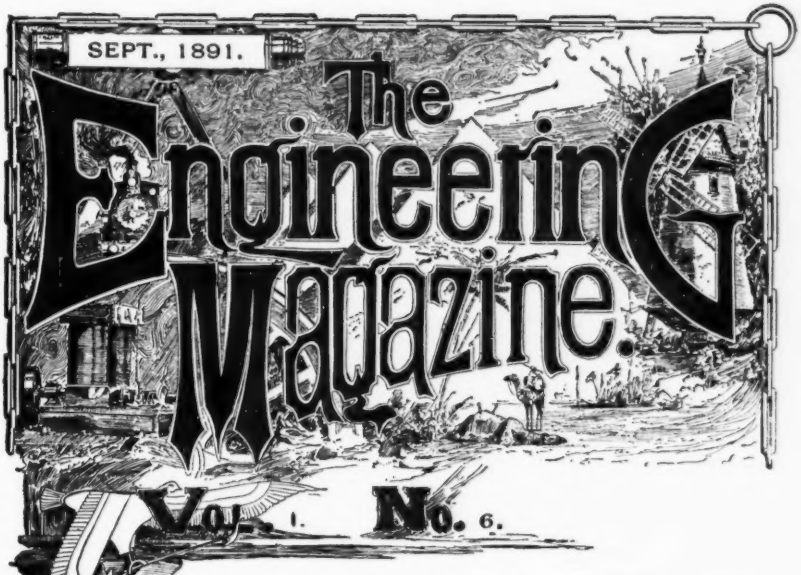

THE VENTILATION OF HOMES AND SCHOOLS.

By Leicester Allen, A. B., M. E.

II.

As a ventilating apparatus or system to be good must be adapted to the conditions of each particular case, it is manifest that only a very narrow view of the subject, as a whole, can herein be presented.

This limitation is inherent in the nature of the subject. In the able and interesting article entitled "What is the use of a Building Law?" printed in the August number of this magazine, Mr. Robinson speaks of "the multitudinous, complicated, various and ever changing conditions of building operations." This pithy phrase is extremely pertinent to the design and erection of good heating and ventilating apparatus. The author immediately adds: "Few people have any conception of the inventiveness that is required in all mechanical operations. From the village carpenter to the engineer, all are continually occupied with new problems, for which new

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solutions must be found." Mr. Robinson is well known as a thoroughly trained and experienced architect, and for him and his like it is unnecessary to say that the latter quotation accurately characterizes the "true inwardness" of the heating and ventilating business, in which each individual design, in its application of general principles, involves variations and practical considerations which make it "a law unto itself." The conditions for isolated country houses and city houses built up in blocks are essentially different, and the conditions for isolated dwellings in the country are never, at least very rarely, the same. It is, therefore, obviously impossible to describe an apparatus fitted to all cases, and in an article like the present I must confine myself to such general features as should enter into the construction of any good ventilating system.

I have used here a much abused word. There are few existing specially designed apparatuses to which the term system is broadly applicable. The "*Ruttan*" system is one of these, and in its improved modern form is a sound application of scientific and mechanical principles from which the best results may be attained. But it is properly a *system* not by virtue of any particular heater or any peculiar heating surface by which the air is warmed, or any special design of fittings. In the sense that ordinary and common appliances are combined and arranged in a special manner to meet special conditions in the heating of some particular building, such a combination is a system for that building. The appliances used are not collectively a *system* except as so combined, yet nothing is more common in current catalogues and in the mouths of salesmen than this term, which has, in most instances, no better basis than some particular form of boiler or radiating surface, with no possible relation to a definite mode of erection, to a particular method of circulating air or introducing it into a building, or to any other considerations implied in the signification of the word.

Of course, such a site for a house or school should be selected as will make good ventilation possible. Air which has been charged with emanations from miasmatic marshes, stagnant frog-ponds, the refuse of slaughter houses, the sour water of starch factories, or sludge acid of oil refineries is not fit for breathing. It is worth while to mention this. In the selection of sites, an oversight or ignorant disregard of such sources of bad air is by no means unprecedented. It must be remembered that the engineer and architect have done all they can with a building on any particular site,

when, on the assumption that the surrounding air is good, they have constructed an apparatus that will introduce sufficient air and so circulate and discharge it as to remove the impurities generated within the building. They are not responsible for imperfections of site, except when its selection has been guided by their advice. However, although carelessness in the selection of site is far too common, I will not further emphasize this point.

It must be constantly borne in mind that good ventilation has for its object primarily the constant and effectual removal of foul air, and secondarily the renewal of a supply of pure air. An old adage has affirmed that an ounce of prevention is worth a pound of cure. The problem of good ventilation should, therefore, be rendered as easy as possible, not only by the selection of a good site, but by the careful attention of architects to certain details of construction. For instance, a house cannot be called well ventilated in which fumes from the kitchen or laundry penetrate to other apartments. The introduction of pure air may, with bad construction, assist this permeation.

I have always believed that the place for kitchen and laundry is the attic floor. Both should be provided with large sky-lights which may be opened whenever desired. These apartments should be reached from the cellar and dining-room by a dumb waiter shaft so arranged that an ascending current of pure air is always maintained in it. A flight of stairs in front rising from the next lower floor may afford access to the mistress of the house or her housekeeper. A similar flight at the rear may be provided for servants. With good ventilation in these rooms, so located and arranged, there can never be the slightest odor of cooking or washing detected in any other part of the house.

Water-closets and urinals should each be provided with ventilating flues, in which a sufficiently strong upward draft is constantly maintained to force a current into them whenever their doors are opened. In this way any foul gases generated in them are immediately transferred to the exterior air.

The size and position of flues are of primary importance. The chimney flue for the heater or boiler ought, for the better class of ordinary sized dwellings, never to be less than 144 square inches in cross section if square, nor less than 14 inches in diameter if round. Inadequate chimney flues are much too common. An inefficient draft, besides being fatal to good heating, is also very uneconomical of fuel. Economy of fuel can only be secured by good com-

bustion. As far as possible flues should be located in inside partition walls, where their interiors will always take the mean temperature of the interior of the building. Instead of this it is a very common practice, especially in school buildings, to locate them in the outer walls. The air in flues so placed, unless special means for heating them are provided, as steam, hot water pipes or gas burners placed therein, will in cold weather be colder and therefore heavier than the air in the building. Cold air will therefore flow down through them into the building. When this takes place the action of the apparatus is partly or wholly reversed, and is fatal to either effective warming or ventilation. More of this in speaking of schools. My experience confirms the belief that for ventilating ordinary dwellings an inflow of air each hour equal to the volume contained in the building is adequate and for ordinary purposes even ample. Tests of air taken from such buildings when the problem is not complicated by faulty construction of drains, water closets and the kitchen and laundry fixtures, show that this rate of inflow meets all the requirements of first-class ventilation when the circulation is properly distributed. But I regard it as good practice to supply and erect an apparatus capable of doing considerably more than this, when a more rapid displacement is desirable, as when the house may be full of people on the occasion of balls, parties or receptions. At such times the conditions approach closely those in schools and other assembly rooms, and the ordinary ventilation becomes deficient.

The inflowing air must be warmed to an agreeable temperature, and these temperatures are not (or ought not to be) the same for different parts of the building. Bath-rooms should have provision for heating them to a temperature of from 90° to 100° F., and even higher when such temperatures are needed, in order that free perspiration may be generated in them when desired in bathing. Bedrooms ought not to be heated above 55°, except in case of sickness; but every complete house ought to have an invalid room in which the temperature can be maintained at any prescribed degree, and in which a specially active ventilation can be carried out as occasion may require. Most people will require a temperature of 70° F. in parlor, dining-room, library, living-room and halls; but a lower temperature is better, say from 65° to 68° F. The latter temperature will be equally as comfortable as 70° ordinarily is if sufficient moisture is imparted to the air. In England where the air is, on the average, much more moist than in this

country, apartments are kept comfortable with a considerably lower temperature than is common here. The most effective means for imparting to air the required moisture in regulated quantity, is an arrangement for effecting commingling of steam with the inflowing air immediately after the latter has passed through the heater-box. This is always practicable in steam-heating apparatus, by the use of a device called an "air-moistener," a patented form of which, now manufactured in this city, meets all the requirements. It charges the air with moisture more or less as required and, at the same time, is cleanly, no water dripping from it on floors or carpets when used on direct radiators, and it is also applicable to indirect radiators. With hot-water heating apparatus as commonly erected, the proper and uniform supply of moisture is not so easy. There is an opportunity for some invention to supply this need. The best that can be done at present with either warm-air furnaces or hot-water radiators is the employment of open evaporating pans, or vessels. Needing frequent attention they are apt to be neglected.

It is, in general, bad practice to introduce outside air without the use of a dust-chamber, in which the dust can settle before the air passes to the radiators. Particularly when buildings are located near dusty country roads, or other sources of dust, the amount of impurity that can be introduced in this way is sometimes quite astonishing. It is easy in most cases to supply this useful appliance without incumbering the cellar with it. The space under a piazza often forms an admirable location for a dust-box. A covered trench of considerable length, having its inlet at a distance from the source of dust, and fitted with a rotating cowl, is an excellent way of leading cold air to the heaters in the cellar. Whatever dust may enter at the inlet will gravitate to the bottom of this trench before it reaches the house, provided the trench is of sufficient size and length. Its walls should be made smooth with a coating of cement. Care should also be taken to locate the inlet of the trench where no foul gases or odors can be wafted to it through the action of winds, and it should also be so located and constructed that no leakage either of gases or liquids from drains can enter it at any point.

The nursery should have floor-heat, so that little children may sit, creep or lie upon it without getting chilled, and its temperature should be 70° F. The play-room for children need not be heated to more than 50° in coldest weather, which is warm enough for active exercise.

The question suggests itself here whether it is possible to so design an apparatus as to give these strikingly different temperatures in different rooms. To this I unhesitatingly give affirmative answer. It may now be done either by steam or hot water apparatus. It is only necessary to place in or connect with the apartments to be warmed the right amount of heating surface, and automatically regulate the supply of heat to this surface according to the temperature desired. Thermostatic regulators may be used for each room. Of these a variety are in successful use. But, in general, it will be sufficient to compute from established data the extent of heating surface needed, and by the use of one or two automatic regulators in the cellar, to regulate both the supply of heat to the radiators and the flow of air over them.

It is only recently that hot water heating has been placed on a level with steam in respect of automatic regulation, although many attempts to secure this desirable result have been made. A manufacturer of hot water heating appliances in the West has patented and introduced on the market a positive, simple, strong damper-regulator for hot water heaters, which not only regulates the heat and inflow of air as promptly as steam-damper regulators do, but also permits the temperature of hot water in pipes and radiators to be safely carried to a point which requires no larger extent of surface than has hitherto been needed for steam heating. A notable economy in the first cost of hot water heating apparatus, as well as a better regulation of it has been secured, an improvement which, when the proper appliance for air moistening has also been supplied, will perfect hot water heating. Hot water heating even without these improvements has already largely superseded steam.

Now as to the ventilation of schools, it will be obvious that some portions of what I have written will apply to them as well as to homes. But there are other points of importance that should be forced upon public attention. The adequately and properly ventilated schools in this country are unfortunately few as compared with the entire number. Many of them are in this respect a disgrace to modern civilization.

The principal faults to be found in schools as regards their ventilation, are that too little cubic space is allowed in proportion to the number of pupils ; that an insufficient quantity of pure air is admitted to expel the foul air ; and that, in many cases when a sufficient quantity is supplied, it is introduced and led out in such a manner that the desired result is not attained.

As I have already absorbed the space assigned to me, I can only very briefly touch upon these important points.

Many schoolrooms containing the correct amount of space for pupils, or perhaps even more than is necessary, are still faulty as regards space, on account of their proportions. It may be set down as a rule amply justified by practical experience, that all space in a schoolroom lying above a horizontal plane 12 feet higher than the floor is, for purposes of ventilation, to be considered as waste space. Each pupil should have 243 cubic feet of space below this plane, that is to say, 20¼ square feet of floor space, or a square each side of which is 4½ feet. How many schools in this country meet this condition? By far the majority of them do not allow more than half this space for each pupil, and in many cases not more than one-third.

How about the quantity of air admitted? To maintain the air in a good sanitary condition in a properly constructed schoolroom, my experience confirms the amount required as stated by Billings, to wit, 60 cubic feet of air for each occupant per minute. For 100 pupils this amounts to 360,000 cubic feet per hour. How many schools come up to this requirement? There are many schools in this country that contain 100 pupils and do not introduce more than 25,000 feet of pure air per hour, and even that is rendered in a measure ineffective because the air is not properly admitted. The pupils do not die in the poisoned atmosphere; many of them will appear reasonably healthy. So do many persons who visit and tarry in malarial districts. But though the effects are not immediate and striking, they are sure, permanent, and easy to be traced to their causes in after years, by those who make a study of disease and its causes. It is scarcely less humane to kill a child than by wilfully ignoring sanitary requirements to cripple it for life physically, mentally and morally, as children are being crippled to-day in the vile atmosphere of many schools.

I regret that I cannot elaborate more upon this subject. I must close with a few words on the methods of introducing fresh air to schoolrooms, and must relinquish my original intention to illustrate this part of the discussion by diagrams.

I have already said something about size and position of ventilating flues. Unless a system of forced ventilation be adopted, either by internally heating the flues, or by the use of a fan-blower, I think it may be safely set down as an established fact that ventilating flues in schools are universally inadequate, no matter

how constructed or where they are placed. I have never seen good ventilation in any school wherein flues warmed only by air currents entering them from the room were relied upon to remove foul air, and I believe the general experience of experts will confirm this statement.

If a squad of policemen should attempt to clear a hall of a riotous assemblage, they would not form in single file and march through the middle or at one side. They would form a rank entirely across the floor so as to cover all points, and when they had thus marched through the hall, it would be cleared. Now, the bad air in a room corresponds to the riotous assemblage, and the fresh air to the squad. It does not answer to let it all flow in at one point and out at another. It must cover all points, or so many points that with the aid of friction and diffusion the bad air is driven before it. The more intermixture can be prevented the better. The ventilation of assembly rooms should not proceed on the principle of dilution alone, though this action always takes place more or less. *Expulsion* should be the main reliance. But in order to do this, and avoid deleterious drafts, the inlets must be greatly increased in number as compared with the general practice in this respect. For a system of upward ventilation, I would, if I could, have an inlet under each pupil's desk. In this way fresh air would be at once distributed to every pair of lungs in the apartment.

But I cannot farther exceed my limit. If in this and the preceding article, I have been able to indicate to some extent what good ventilation is, and some of its principal essentials, and in such a way that the general reader can understand them, a part of my original purpose has been carried out. There could be much more written, and I shall hope others more competent than myself, will not let the subject drop here.

INVESTMENTS IN MINING PROPERTIES.

By Albert Williams, Jr., M. E.

THE subject of mining investments is so broad a one that it will be necessary for me to limit the scope of this paper to the gold and silver mines of the Far West, and the mines of lead and copper worked for their precious metal contents.

The crude ideas about mining formerly prevalent among those not personally engaged in it are gradually passing away. The investing public is becoming better educated as to the real character of the industry—partly by dint of some awkward experiences, and partly by the technical press and hurried tours through the more accessible parts of the mining region. Yet there are many intelligent people who still persist in the delusion that mining is distinguished from other business in that the element of chance is so predominant that the common precautions observed in other forms of investment may be disregarded.

The truth is that there is far less uncertainty about mining than was formerly the case. Many of its operations can be planned and estimated for with nearly the precision of railway work or bridge building. This is true of the design, selection and erection of machinery, the requirements and duty of which are perfectly understood. It is also true, to a less degree, of such work as driving adits, where the cost of drilling, blasting and timbering can be computed as closely as in railway tunnelling, the variations from the estimates hinging upon unexpected hard rock or loose ground. In shaft sinking, heavy flows of water may retard the work and increase the expense by necessitating additional pumping capacity, yet the cost of sinking a given distance can be computed roughly. Uncertainty always exists as to the finding of ore and the character of ore to be met with. Geology is by no means an exact science, and only gives information of a general character amounting at best to strong probabilities that under certain conditions such and such an occurrence may be looked for. The remedy for this uncertainty is of course to keep the mine well opened up ahead of the stopes. But even here considerable progress has been made. At least we have now a negative knowledge ; that is, an understanding of just where theoretical geology ceases to be a reliable guide.

At present there is no excuse for wild experimenting in the reduction of ores. In the early days of precious metal mining in the West, this was a fruitful cause of failure. Often a company would put up a great mill or a smelter before its mine was proved capable of supplying ore, or built works for a process unsuited to the ore. The wrecks of buildings and the abandoned machinery scattered throughout the older districts are monuments of past follies, but they have their uses as warnings for the present. Such experiments are rare nowadays. There is of course still room for improvement in metallurgical methods, but the margin has been narrowed down wonderfully in the last few years. Smelters buy ore on a basis of 95 per cent. of the assay value, and good mills and lixiviation works are saving from 80 to 90 per cent. and over of the actual contents of ores; so that any new process or appliance will have to do very good work indeed in order to compete with and supplant the methods recognized as standard. Careful sampling, plenty of assays and analyses, with test mill runs and sample lots shipped to a smelter, will always indicate the proper mode to be pursued and will show what can be expected of an ore; and no sensible man will settle upon a process until these preliminary tests have been made.

Miners in most parts of the country are no longer dependent upon their own resources for the reduction of ores. The ore buyers and smelting works will always accept any ore having value, no matter how rebellious. With the growth of the railways and the establishment of public sampling works through which ore can be sold in the open market to the highest bidder, there is little trouble in disposing of a mine's product. This is a great advantage to the miner, as he receives immediate returns for his output and is saved the first cost of reduction plant and the trouble of operating it. As in other directions, the metallurgical business is being concentrated in comparatively few large custom works at favorable central points where fuel, etc., are cheap, and where they can operate to the best advantage by commanding a great variety of ores.

Mining machinery, appliances, tools, explosives, and all supplies are not only cheaper but better than ever before, enabling work to be done more rapidly and effectively, and cutting down the labor account. Freights are now much lower in almost all parts of the mining country, owing to the rapid extension of railways. This is a very important item, one that in many cases is the critical point between profit and loss. It is now possible not only to

obtain supplies and send out products more cheaply, but also more regularly, with less dependence on the season, and at more uniform rates, so that figuring on new enterprises can be closer than formerly. Wages have been somewhat lowered, the cheaper cost of living giving the men a better position than formerly, however. The grade of labor is also improving, and more skilled hands are in the field. There has been no great trouble from strikes hitherto, though just now the eight-hour agitation causes a little uneasiness in some quarters.

A point worth remembering is that the product of precious metal mines is at once marketable. Fluctuations in the price of silver have of course affected profits, but not to the same extent as the ordinary changes in the prices of most other commodities or manufactures. Gold and silver ore and bullion can always be disposed of. There is no hunting for customers, no waiting for a turn in the market, and no competition—at least none that is directly perceptible.

Another advantage that investors have at present is the large number of trained engineers, assayers, surveyors and metallurgists whose services are available. The increase in the number of professional men is partly due to the technical schools and still more to the wider experience which has been had. When we depended upon a handful of engineers, mostly graduates of foreign schools where mining under far different conditions from American practice was taught, it was only natural that mistakes should have been made which to-day are avoided by those rightly called mining men.

The success of a mining enterprise rests primarily on the mine itself. Evidently with nothing to work on the most skillful operations would be hopeless. But that is not all. There have been a very few mines so good and so constant as to defy technical bungling and financial maladministration. No reliance is to be placed on the chance of such abnormal occurrences. To put it briefly, there are three things about mining to be taken into account: first the mine; next the way in which it is handled, and lastly the financial management. A failure in the first is necessarily fatal; in the second, usually so; in the third, extremely dangerous, to say the least.

Persons at a distance owning mining property are undoubtedly at a disadvantage as compared with owners on the spot who are at hand to watch their interests sharply. Outsiders have to rely

on the skill and honesty of their local managers. If they do not, but prefer to direct the working of an Arizona mine from a New York office, they reduce their superintendent to the rank of a foreman, and the result is almost certain to be confusion. But if the directors really understand something about mining they will look to their superintendent to form and submit definite plans, and then, if approved, he will be responsible for carrying them out. Whenever an extraordinary expense is proposed, as in buying new plant or projecting a long adit, he will of course seek the approval of the board. That gained, he should be left unhampered. Hence it is all the more important that care should be exercised in the selection of superintendents. Cheap ones are usually poor ones. Those who have proved their capacity are sought after and are paid accordingly. Closely figuring in this direction is poor economy. An incompetent man can waste many times the amount of his salary by a single ill-judged move. It is easy to find out what a man's rating in the profession is, and fortunately there are many good engineers available.

A mine to be a good "company mine" should be a large one and worked on a large scale. In order to pay dividends on shares numbering from 100,000 to 1,000,000, the profits have to be considerable or the dividend per share becomes insignificant and disappointing. The number of mines which pay handsome incomes to a single owner or a firm is very large; yet such mines, netting even $10,000 to $50,000 a year will not satisfy the shareholders in a big corporation; and the chances are that the profit, being considered too small to make a good showing in dividends, will be frittered away. It is seldom for instance that the California corporations, operating mines mainly in Nevada, offer their shareholders less than 25 cent dividends, which on the usual capitalization of $10,000,000 in 100,000 shares would mean the very respectable sum of $25,000. One such dividend a year would be a creditable exhibit for a mine owned by one or two persons. Thus to be a promising purchase for a proposed corporation, a mine ought to be one which can be worked by a considerable force to insure steadiness of output. A rich but narrow vein, where only a limited number of men have room for stoping, may be the best for individual ownership, since running expenses are low; but it is not so good for a company as a large deposit of lower grade, capable of being extensively opened and presenting large breasts in the stopes, with a more regular output. The most reliable gold mines have been

of very low grade but with large and regular deposits. In California $15 a ton is considered a very fair basis for a company mine if the ore is in quantity; but a very much lower tenor has been worked with great profit in the exceptionally large deposits of the Black Hills and Alaska, where $5 a ton would leave a liberal margin for dividends. In fact most of the famous mines have not been of high grade, the gold ore rarely showing any metal to the eye, so that most miners have a prejudice against what are called "specimen mines." The same thing holds, to a less extent, with silver and doré mines. On the Comstock the heart of the "big bonanza" (the greatest ore body ever known) only averaged $80 per ton, including the rich streaks, and that was thought to be very high. The great silver mines of Montana have not averaged anything like as much. There have been exceptions, notably in Arizona, Colorado and Utah, where high grade ores in comparatively small amounts have produced largely; but speaking generally, the celebrated mines have not been of that class.

Undeveloped "prospects" should as a rule be avoided by outside investors, and so should large groups of insignificant claims. Our English friends have manifested a fondness for investment about which it could be said that the property included twenty or more claims, each of which would be described as a mine. But a prospect is not a mine, and a whole group is often no better than a single location. The 3000 feet of a full claim is as much as can be worked from one plant, and to dissipate effort over many scattered openings is poor policy for a company.

But, it may be asked, if a mine has been developed so that its value is evident, why should the owner desire to sell? A very pertinent question. To be frank, it must be confessed that holders usually want more money than is in sight. Yet this is not always so. There are instances in which to properly operate a mine already proved to be good, a preliminary outlay for machinery, roads or other improvements is called for, without which the holders are unable to work on a profitable scale. Sometimes good mines are offered for sale by owners interested in other mines or occupations and who are willing to "clean up" on a part of their holdings.

It is not safe to buy a mine on its record alone. Every ton of ore taken out is a ton the less in the ground. In this mines differ from those kinds of productive property whose yields may go on indefinitely. Some mines with a grand history, but which had been worked till a mere shell remained, have been sold at high figures

in the East and in Europe, on the strength of their past reputation, just at the time when, or a little before, the owners became convinced that their territory was about exhausted. A worked out mine is far worse than an undeveloped one; and its extensive development, showing where ore has been but now is not, offers a good opportunity for deciding against it. The record of the old stopes is of course promising for contiguous unexplored ground. Nevertheless a mine which has yielded $1,000,000 is certainly worth just $1,000,000 less than it was before that million was taken out. Consequently, as a mine is not a permanent but an exhaustible quantity, calculation should be made as to the returns required, as a sinking fund, to extinguish the original outlay within a certain length of time. For this reason it is right to expect mines to yield higher percentage returns on invested capital than continuously productive property.

The life of an actively worked mine in the United States is shorter than elsewhere, owing to the rapidity with which operations are pushed here. It will not do to refer to the Cornish and German mines which have been worked in a slow way for centuries. Our mines, individually, will not last so long. Some very productive ones have been worked out in a couple of years or so. Our oldest mines are the gold veins of California and Colorado, but these have not been operated with much vigor. In the future it will not take twenty years to stope out a mine to a depth of 2000 feet, with modern explosives and power drills. Unless extraordinary flows of water or intense heat are encountered it will be possible to go down 4000 feet or more if the ore is good enough to meet the increased cost of operating at that depth. But even that limit can now be reached with a speed which would astonish the ancient miners.

There are more kinds of mines than of real estate, and each has to be appraised on its own merits and with due regard to its peculiar conditions. A common error is to consider all mines as about the same thing. But they vary as to their size, their richness, the character of ore, facilities for working, climate influences, transportation connections, proximity of supplies of timber, fuel, etc., and so on indefinitely. A study of a mining "proposition" necessarily involves careful weighing of all these considerations, apart from the intrinsic merit of a mine. The single question of locality may make all the difference, for a mine favorably situated as to the item of freights, might be quite unworkable if it were somewhere else.

Some mines—not so very many—have been self-sustaining from the outset. These were usually worked on a small scale at first and were slowly developed by means of their output. But a mine which has always paid its way is an exception. Many which were extremely profitable while the rich oxidized surface ores were being worked have required considerable outlay when the zone of baser ore below the water level was reached, both from the need of opening the mine on a larger scale and from the added expense of pumping and hoisting machinery. When a company takes hold of a mine it is often required to begin by putting money into it for plant and further development before it is in shape for rapid and economical working. This very fact is the opportunity of the capitalist. There may be an exaggerated notion among miners as to the pressing need of capital for development; but it is none the less true that a good financial backing will help most miners. It is not necessary to throw money away because a working capital is in hand.

A large grain of allowance must always be made for statements in the local press. As a general thing the newspapers published in the mining regions have little to say about the great mines. These can stand alone. But the editors, without conscious misrepresentations, like to help along the smaller claims, especially if owned by personal friends. So when Bill Jones, the prospector, comes into the newspaper office with a handsome specimen for his friend the editor, from his Hidden Treasure location on Last Chance mountain, he is sure to get a nice "write-up," which will relate that "Mr. Wm. Jones was in town last week from his magnificent discovery. The Hidden Treasure vein averages 6 feet in width, and the ore assays 600 ounces per ton"—both of which statements may be perfectly true and satisfactory to the editorial conscience; that is the vein may be 6 feet wide, and a small picked specimen (not a sample) may assay 600 ounces silver. These local notices are very misleading, and they have been copied into prospectuses and even Government reports. The temptation to say a good word for everybody, and the obligation the editors feel themselves under to put the best face on the camp, are too strong. The technical press is somewhat safer, inasmuch as the reprinted extracts are usually relieved of a part of their overstatements in the process of condensation. But the technical papers are published at a distance and obtain most of their news at second-hand or else from local correspondents, who are afflicted with the same patriotic

desire to boom their particular localities. Then the visitor to a mining camp in search of bottom facts will have to become very well acquainted before he hears a disparaging whisper about any property in it.

To ascertain as nearly as possible what a mine is really worth, it becomes necessary for the buyer to call in the disinterested professional assistance of some one who knows. There are many men of irreproachable reputation who are fair judges of mines, not merely the "experts" who make a specialty of examining and reporting, but the working engineers as well. Such men are not infallible, but they certainly know more about mines than the laity. They hold the same position as consulting physicians. They may make mistakes—as do the doctors—but at least their opinion is worth more than that of persons who have had less opportunity for study and experience. A good mining man can usually form a fairly reliable opinion on a mine that is sufficiently opened to see what it is like. He can at all events give negative testimony, and that is something. It is well to note here that the day of self-styled "professors" and quack "experts" is waning. They are soon found out and reach their level. The relief from incompetent advice will be a great boon to investors.

In the transfer of mining property to a corporation there are several successive stages, at each of which some one expects to make a profit; so that the shareholders in the final organization instead of dealing directly with the original owners, must necessarily pay, in addition to what the latter receive, something in the way of bonus or commission to cover these charges. Thus it happens that a good mine, worth at the outside say half a million dollars, is put on the market at the equivalent of two or three millions. All this leads to over-capitalization—in other words a dead weight on the mines. About two years ago, the British Chancellor of the Exchequer ruled that the government fees for registry should be in proportion to the nominal capital. And a wise ruling it was, too. It at least had a tendency to shut out that class of schemes which had no financial backing to start with, though it does not prevent audacious promoters who have money enough and are willing to risk it, from floating over-capitalizations. Colorado and some other States have restrictions aiming to the same end. If they do hamper the formation of corporations, they also effect some good withal.

There ought to be some reasonable ratio between the actual value of a property, the cash paid for it, the nominal capital, sub-

scription rate, working capital and reserve. As a rule the nominal capital is altogether too high in proportion to what it stands for, and the working capital and reserve are absurdly small. The result is that corporations capitalized up in the millions begin work with insufficient funds and soon find themselves in straits. If they are organized on the non-assessable plan, or cannot realize on treasury stock, it is extremely difficult to obtain means for carrying on work after the first enthusiasm has worn off.

Every dividend-paying mine should carry a healthy bank account, to tide over times of *borrasca*, meet delays from accidents, and be in readiness to stand the drain of unlooked-for expenditures. Witness the Ontario management and that of some few other companies. In 1875, when the Consolidated Virginia works were destroyed by fire, dividends went on as usual. A steady payer is always in better condition than a spasmodic one. When company officers, in the ambition to make a brilliant showing, disburse all the profits of a month's run in a single dividend, they are taking large chances both as to the mine and the stock, for the next month may see an empty treasury or debt. If the object of mining is to manipulate the price of shares, that is another matter. We are here considering mining as a business.

Mining purchases are made on two widely separated ideas. They may be either for investment, that is, to make money out of the mine itself; or merely as a speculation, with the purpose of making money out of the stock, or by reselling outright. The latter is a tempting bait and can never be entirely eliminated. And there is something to be said in favor of the much abused middlemen, for without them many meritorious undertakings would not have been carried through. But people are beginning to understand that mining, conservatively conducted, is very profitable, and hence there is a greater disposition to favor legitimate mining as contrasted with mine speculation. The oft-mooted question, "Does mining pay?" is pretty conclusively decided in the affirmative—with certain qualifications. It does not, if prosecuted loosely, and regarded as a mere gamble. When treated just as any other business should be, it is on the whole extremely remunerative. There are failures not due to bad management; but so there are in commerce and manufacturing. There are also phenomenal successes. But taking the whole range of mining investment, the results are certainly favorable. No definite data exist from which to derive averages, and only vague conclusions can be attempted. One can

state the total yield for a year and the dividends for the same period ; but we have no means of ascertaining the actual cash investment (not nominal capital) of the companies, nor the receipts by individual owners. It is certain that a large population is supported directly and indirectly by the mines. If all these people were no more than self-supporting, it would be a positive gain to the nation. Economists are agreed on that. What they produce is an actual increment to the world's wealth—something which did not exist potentially before, and not a mere transformation as with manufactures.

WHY THE STATE SHOULD NOT OWN THE RAILROADS.

II.

By Benjamin Reece, C. E.

IN a former paper it was shown that the mechanical features of our railways, together with the exigencies of the railway service, require them to be operated as entireties. It necessarily follows that any remedial scheme contemplating the free and open use of the rails to any and all applicants, even though subjected to one general system of despatching and inspection, is utterly impractical; and even if skilled and expert trainmen could be induced to make the trial, under any system of despatching now known the experiment would undoubtedly prove a very costly one, to say nothing of the consequent destruction of property and loss of life. On the other hand, should the States assume to engage in the management of the entire business of transportation within their respective boundaries, we would be soon brought to realize that our interstate commerce would in a large measure pass from Federal to State control.

It may be claimed that minute and comprehensive Federal regulations governing the transfers between the States could be rigorously enforced; but to constitutionally deny the rights of the States to the direction of interstate commerce, and then invest them with the complete control of the means of transportation, reminds us of the imprisoned culprit, who, when told by his lawyer that they could not legally put him in prison for his offense, contemptuously exclaimed: "Can't put me here! Why they have got me here."

The distribution of cars and their movements can never be regulated by inflexible rules, but must largely remain a question of individual judgment and control.

For illustration: heavy shipments of dressed beef are made from the large packing centres to the towns and cities of the Union. It will easily be recognized that the shipment and distribution of dressed meats by rail requires regularity of service, promptness in handling and high rates of speed in transit. Success has

been attained only by the constant vigilance and special facilities provided by railway officials, who in every conceivable manner seek to increase the sources of revenue for their respective lines. This branch of trade had only been fairly established when local butchers found that this competition materially reduced the profits of their trade; whereupon they sought to secure a remedy by legislation. The States could not prohibit the shipment of dressed meats, but aimed to destroy the traffic by the enactment of inspection and other harassing regulations. This simply resulted in increased endeavors by the railroads to continue a business which added to their revenues. As the rulings of the Federal Courts compelled the States to legislate within prudential limits, these attempted restrictions were generally unsuccessful, and the traffic measurably increased in spite of adverse legislation. But with the State control of the railways this branch of trade, requiring the heartiest co-operation of the transportation companies to insure success, would be placed at the mercy of State employés, confessedly hostile, who by the manipulation of cars and movement of trains could utterly ruin the business, and do it in such a manner that no criminal intent could be shown, and the courts would be powerless to provide a remedy. The recent contention about the freight rates on salt from Michigan compared with those imposed on the Kansas product suggests what State control of railways would involve. The illustrations given are suggestive only, and the more thoroughly the question is examined, the more certain it will appear that in a safe and satisfactory solution of the transportation business of the country there can be no halting place between individual or Federal ownership and control.

As the abuses complained of in the conduct of transportation ultimately resolve themselves into a question of cost, we will proceed to ascertain if Federal control would provide more efficient service at similar rates, or secure equal results at a diminished cost for same; for if neither of these advantages is to be attained any change from corporate to Federal control would manifestly prove unwise.

In the article which appeared in the May number of THE ENGINEERING MAGAZINE, the writer made reference to the Erie Canal as having tended to reduce and keep down the rates charged by the railway companies. Be that as it may, it is nevertheless a fact that railway competition forced the State to make frequent reductions in its toll charges, so that the canal has been practically

made free to those using it, the public paying to the carrier the actual cost of haul only. Yet, in spite of these reductions, the proportion of coarse and bulky freights moved by rail has suffered no diminution.

The boatmen's charges, however, are not the only ones exacted from the people of the State; for the interest upon the original cost, current or funded, as well as for the expenditures for repairs and improvements, represents an annual fixed charge; but because it is or has been paid in the form of taxes it is seldom recognized as entering into the cost of transportation.

For the Federal Government to secure the ownership and control of the country's railways the purchase or confiscation of existing lines is necessarily involved. As the prevailing sentiment of the people is overwhelmingly opposed to any measure of confiscation, we will base our examination of conditions and results upon the theory of purchase by the State.

A legitimate commercial basis of value is the immediate and prospective earning power of the properties in question. There is however, a commercial value to non-dividend paying roads, which partake of the nature of blackmail, in so much that the owners of remunerative properties are frequently compelled to purchase them, in order to prevent such roads from falling into the hands of rival companies who would operate them simply as bushwhacking lines, to harass and perplex competitors. Should Federal control be acquired on such a commercial basis, the interest to be paid by the people in the form of taxes would largely exceed what they now pay in that proportion of the rates which represents the interest on bonds and dividends on stock; for with Federal ownership the losses now sustained by the owners of unremunerative lines would fall upon the people by reason of their purchase.

If, then, we find at the outset that the proportion of cost due to fixed charges is measurably increased it would be incumbent on the Government to perfect an organization superior to the skilled and highly specialized forces now engaged in the operation of our railways. There would have to be exercised the same scrutiny in the purchase of supplies, the same discriminating judgment in the adoption or rejection of new devices, the same watchful ingenuity in keeping down expenses and adjusting the expenditures upon the several lines to the magnitude and importance of the traffic. Sidings and facilities for mines, quarries, and manufacturing concerns, would have to be considered and determined with the

commercial scrutiny now employed. The same vigilant attention and prudence would be required to judiciously locate and properly time improvements, such as the enlargement of terminals, erection of buildings and shops, construction of second track and necessary sidings, additions to rolling stock, motive power, etc.; and all this would have to be accomplished through the officers of a government which has been occupied in providing additional pensions for soldiers; enlarging the bounties of ship-owners; extending land grants to railroads; adding to taxation to protect the manufacturer; and legislating to reduce the hours of labor for workmen.

This brings us to another point. In order that the Federal Government may perform the transportation service without an increased cost as compared with present rates, it must not only provide a more efficient corps of employés, but it must exact the same hours of labor, and adhere to existing rates of wages. But as the Federal Government has already legalized eight hours per day for labor, and as government clerks and workmen are paid considerably higher rates than those paid for similar services by individuals or corporations, a marked retraction in legislative tendencies would be required.

Failing to readjust the hours of work and the rate of wages as above, the increased cost to the public would be enormous. Again, as now managed, the forces on our railway lines are added to or taken from as the exigencies of the traffic require, while the rates of wages rise and fall in obedience to the law of supply and demand.

This flexibility of adjustment would be wanting when subjected to the rigid rules and red tape of officialism; yet this condition is inseparable from governmental control, which makes personal judgment subordinate to legal regulations. Therefore, simply making mention of the enormous extension of the Federal patronage by including within its category the seven to eight hundred thousand men now engaged in the transportation business of the country, and barely alluding to the general methods of appointment now existing and which will probably continue to prevail; we can readily see that, let the governmental management of our railroads be ever so wise in judgment, honest in purpose, and faithful in performance, the very conditions incident to State or Federal control compel a higher cost for actual service than is now charged by railways to include actual cost, taxes and fixed charges.

If, in this examination, we base the purchase price upon the actual value of the properties, independent of their earning power,

the results attained would not materially differ from those already noted. There are now in operation in the United States over one hundred and sixty thousand miles of railway, representing an aggregate capitalization and funded debt of more than nine billions of dollars, being an average of about fifty-eight thousand dollars per mile. The question at once arises as to whether this amount fairly represents the true value of the properties in question. It is not denied that a considerable part of it was made up of watered stock, but it must be remembered that frequent reorganizations of bankrupt roads has led to important reductions in the amount of stock originally issued.

Again, enormous sums of money have been expended in the betterment of railway terminals; expensive real estate has been purchased; extensive switching yards have been provided; highways and street crossings in many cases have been bridged or otherwise protected; high trestles filled with earth; inexpensive wooden structures have been renewed with arch masonry or permanent structures of iron; station buildings have been enlarged, as well as increased in number and perfected in accommodations; heavy steel rails have been substituted for the light iron rails originally laid; various systems of signalling have been introduced; the rolling stock and motive power have been increased many fold; grades have been reduced, alignment improved, the standard of road beds raised and thousands of miles of second track and sidings have been laid. For many of the enumerated betterments neither stock nor bonds were issued. When the enormous increase in the value of real estate is added to the original cost of the older roads it is fairly assumed that many of them could not be reproduced for the face value of their issues of bonds and stock. The statement has been made, and remains uncontradicted, that the real estate owned and occupied by some of the more important lines, valued at the selling prices of contiguous property, is worth more than their entire funded debts and capitalization of the same.

But in this question we are not entirely left to conjecture, for when compared with the cost of railways in other lands, notwithstanding the higher cost of our materials and rates of labor, the showing is particularly favorable.

The English railways cost three and one-third times as much as ours are capitalized for; the French two and one-half times; the German double; the Hindoo one and a half times; and the Australian about one and one third as much. The average interest

on the total capitalization has for the last three years been a very small fraction over three per cent. per annum, and it would tax the resources of this government to the utmost to float at par so large an amount at so low a rate of interest. To find a market for one thousand millions is an entirely different question from placing nine or ten times that amount of bonds, and the chances are that a higher rate of interest would be required. As in the first instance cited, the Federal Government would be compelled to conduct the transportation business of the country more skilfully and at less cost than now, or the expense of the railway service to the public would exceed the amount now paid by them to existing corporations. Under such conditions the change from corporate to Federal ownership and control would be both unwise and wasteful.

But a broader and more fundamental objection obtains than any of those yet named. The commercial spirit is not restricted by political limitations or circumscribed by territorial boundaries. It is cosmopolitan in conception, reciprocal in action and world wide in operation. With the growth of commerce has come the extension of human sympathies and trust; with the growth of mediæval towns the intense spirit of comradeship gave place to loyalty to the community, tribe or clan; with the highways and canals of commerce those feelings were still further diffused throughout the States and nation of which the minor groups formed part. The age of steam has more closely knit together the interests of various climes and distant nations through the benign influence of commerce; the desperate energy expended in wars of conquest and spoliation has been transferred to daring explorations and productive colonization; and instead of the ancient glory of a universal empire procured by the sword we have a universal brotherhood by reason of mutual trade and friendly intercourse.

The present commercial interdependence of the states and empires of the world, was well attested when the financial embarrassment of the relatively inconsequential Argentine Republic depressed exchanges in the money centres of the globe. An equilibrium was preserved and threatened wide-spread financial ruin was averted by the mutual assistance and reciprocal concessions of the world's bankers.

Upon the other hand, the political spirit is sectional in conception, coercive in action, and restricted in operation. While the commercial spirit points us to broader unions and augmented trusts, political supremacy carries us back to selfish aggressions and irre-

pressible contentions. The political bias is manifest in State legislation, which under the guise of license and inspection laws evades the provisions of the Federal Constitution, and under the pretext of police regulations it is sought to obstruct interstate commerce, and to remove or weaken competition. The commercial spirit is discoverable in the demand for commercial union with the States of South America and the annexation of Canada. Arbitration between nations, postal unions and international treaties are the outgrowth of commercial intercourse. Standing armies, custom-houses and international jealousies are the relics of a decaying political ascendency. The union was made possible by the unrestricted commerce between the States, and commercial integrity of the States has conserved the political union. Interstate commerce has remained, practically as well as theoretically, beyond the control of politics; hence its growth has been normal and unrestrained, and the older States have found themselves enriched by the settlement and expansion of the new. While the commercial spirit has thus tended to a closer union of those subjected to its influence, the political spirit has served to disunite and array against each other the several members of each political group. Thus the body politic has been divided into warring groups each seeking special advantages and self-aggrandizment.

There are seemingly none left to conserve the general interest, and the welfare of all is neglected in the struggles of individual greed, while the public necessity has given way to the more persistent demands for local and class wants. Look at pension, tariff, subsidy, bounty, silver, labor, river and harbor, and proposed Alliance legislation, and mark the dispersion of political forces into minor groups, each organized to loot the treasury. It is theoretically maintained, even by the beneficiaries of tariff legislation, that international trade is, and should be, non-political; whereas practically, and in fact, it is sought to be made the veritable foot-ball of political caprice. Once place the transportation lines under control of the Federal Government, the broadening and humanizing tendences of commercial intercourse will be checked by selfish aggressions, the offspring of political agencies.

If the cost of internal transportation should be borne by general tax, besides being confessedly unfair, it would tend to debauch the service and lead to wasteful methods. Imagine, if you can, the strife which the settlement of rates and classification would engender. The shippers of like commodities would league together

to secure favorable legislation for themselves, and the body politic would be still further divided into as many distinct groups as there are different classes of commodities for shipment. In the Alliance States the clamor for new railroads has been the loudest and most persistent, and legislation to stimulate construction has been the most far-reaching. Railways in those States have been constructed with a freedom suggesting that they should take the place of ordinary highways. How far such construction has been carried is well illustrated by the railways of the State of Kansas alone, which exceed by about thirty per cent. the entire mileage of the New England group. It was expected by the public that this multiplicity of railways would secure lower rates of transportation, whereas in fact, the maintenance and operation of unnecessary lines has added to the charges made against the shipper, and reduced the profits or increased the losses of the owner. It is not in New England that we find adverse legislation rife and demand for State control persistent, for it has been the policy of New England to grant the right of eminent domain upon the grounds of public necessity only.

Even under the loose methods which obtain, railway construction has in a measure been restricted by fears of loss to the builder; but with the people still insisting on more railroads, and with the example of river and harbor and public buildings legislation fresh upon our minds, what shall we expect of the combination of legislators when every constituency will demand new railroads to be built by the Federal Government? Commercial considerations would have no weight whatever. National questions of important moment would be set aside for the consideration of schemes which would intensify the selfish greed of communities and arouse local dissensions and jealousies in every section of the Union. Internal commerce, which has been measurably free from political interference, has been developed on normal lines directed by individual prudence, energy and skill. Considerations of justice and utility demand that it should so continue. Evil consequences will inevitably follow if the transportation interests of the country are subjected to such violent changes as are typified in the tariff, the currency and free coinage legislation. Internal commerce, which has so far tended to strengthen the political union, will, when subjected to political control, arouse sectional animosities and cause economic loss.

THE INIQUITY OF LEASING CONVICT LABOR.

By Albert Roberts.

RECENT riotous demonstrations of coal miners in East Tennessee against the employment of leased convict labor in the coal and iron mines, has emphasized a growing popular disapprobation of the Convict Lease System in all the States where this prison management prevails. No little sentimental rhetoric has been expended, from time to time, in homilies against the system, in which its inhumanity has been portrayed as infamous and its wastefulness as Folly's crown of folly. But neither moral or economic considerations have had such weight in influencing an active reformatory movement as the threatening protest of the free miners against competitive convict labor. Just as the sordid self-interest of capitalists and the pecuniary consideration of tax-relief to communities counterbalanced any moral scruples against the inauguration of the system, so do self-interest and pecuniary considerations on the part of the free labor class now promise its abolition.

The convict lease system exists in all the Southern States, with the exception of Maryland and Delaware. In some of these States it was doubtless adopted as a protection against the vagabond class, composed almost wholly of the freedmen fresh from slavery and the tremendous and, to them, wonderful results of the greatest civil war of history. As slaves, it must be admitted, they had thought little of petty pilfering, and as freedmen, many of them believed they could steal for a living. The Southern States were impoverished, bankrupt to the verge of repudiation of State debts, and without financial resources. An increase of crime following a demoralizing civil war swelled the list of convicts until prisons were overcrowded, and where prison room was ample, the expense of feeding, clothing, and guarding greatly increased the tax burden. In many, if not all, of these States, the effort to shift this tax burden was the incentive to the change of the prison management, and the grave error of the change was in the idea born of the demoralization of the times and of the poverty of these commonwealths, that their penal institutions should be self-supporting. It seems not to have occurred to the statesmanship of that period that the

convict is a human animal, and his body and soul not the property of the State in that both may be crushed out in the effort to reimburse the State the cost of his scanty food. Nor did the law-makers seem to reflect that the same idea logically applied to other State institutions, such as public schools and asylums for the insane and blind, would effectually close them, insomuch that not one could exist on a self-supporting basis. If there were qualms of conscience against the proposition in the outset, they were quieted by the pecuniary consideration of relief from taxation—endured, first as an expediency, and finally embraced as a new economic discovery. The great industrial development succeeding the war in all the States where the least system prevails, the building of railways and levees, the opening of mines, and the cheapness of the labor of the convicts for the accomplishment of these needed improvements, closed the eyes of communities to the evils of the system ; not the least of which was the swiftness of convictions for petty offenses and the alacrity with which new recruits were added to the prison workers. An illustration of this demoralizing tendency is reported in the case of a lessee of prison labor, privately offering extra fees to district-attorneys for every fresh conviction.

The embarrassments of the Southern States in their efforts to apply economic methods to prison management gave rise to two systems—the Contract System and the Convict Lease System. The first, under certain restrictions, leased the convicts' labor within the prison walls during certain hours of the day, subordinate to the official management of the prison. Under the Convict Lease System, the prisoner and the prison management are all farmed out into private control, and an intelligent reformatory system is impossible.

The features of the leasing system vary in different States. In some, the State retains the penitentiary in charge of its officers and leases out the convicts in gangs to persons who use them anywhere within the State boundaries, in private enterprises or on public works. In some cases the entire prison with its shops and machinery and the free use of all the convict labor are leased for a term of years, and the convicts worked within or without the prison limits, and transferred from place to place under armed guards and quartered in camps or in stockades convenient to the fields of labor. In some States the lease goes so far as to assign to the lessees the entire custody and discipline of convicts, and

even their medical and surgical care. The worst feature of the system is the practice of sub-leasing, and the question has been raised, as in the Coal Creek case in Tennessee, the scene of the recent miners' riot, whether the State law gave to the original lessee the specific right to sub-lease,—such disposition of the convicts not having been contemplated by the Legislature.

In Tennessee, where popular disapprobation first assumed the eloquent, if lawless, aspect of a physical protest, threatening a conflict between the indignant free miners and the State militia, the lease system has been in operation for over twenty years, beginning in 1869–70 under the Republican régime as a contract system, the labor being employed by the contractors within the prison walls. The Act of February 5, 1870, required that no convict be leased or hired to be worked outside the prison yards except by and with their consent first had and obtained in writing, but this clause was repealed in June of the same year, and some convicts were leased or hired to a coal mining company; and by the Act of February 1, 1871, the inspectors of the prison were authorized to establish at the Tracy city and Coal Creek mines, branches of the State Penitentiary. There was much opposition from artisans and skilled mechanics throughout the State at this time to the employment of convicts in the penitentiary building in the manufacture of wagons, agricultural implements, wooden-ware and other articles; and the issue was raised during the first Democratic administration succeeding the Brownlow régime as to the future policy of prison management. The earning capacity of the convict laborers within the prison walls had been falling short of the cost of its maintenance by some $30,000 annually. As some of the convicts were already hired to mine owners outside, it was proposed that the State purchase the Sewanee coal mines on Cumberland Mountain and remove the prison from the State capital to that point for sanitary and economic reasons, and for the political reason that, thus employed in coal mining, they would come less in competition with free skilled labor than in any other way. This scheme was pronounced inexpedient or impracticable, on the ground that the State could not engage in the business of running a coal mine, and, if it did, past experience had demonstrated that State management of the labor had always resulted in loss. The argument was advanced that the cheaper production of steam coal would enable the State to foster its infant industries, but the tax relief consideration outweighed all others, and, after much debate,

the policy of leasing all the convict labor was adopted, and in November of that year the State leased to private parties the penitentiary building, shops, tools, and the free use of all the labor of the convicts for five years. The lessees were empowered to work the convicts at any place in the State, and to have full control of the plan and character of the work in which they were to be employed. The State, by the terms of this lease, was to be protected against loss or expense, and was at the same time to retain supervision over the management of the lessees, so as to guard the convicts against cruelty. The consideration was $100,000 annually, in equal quarterly installments, the State to be clear of all expenses on any account except the salaries of the Superintendent, Warden, Assistant Warden, Surgeon and Chaplain, which were to be provided for biennially by legislative appropriation. The official records of the operation of the system during the two years ending December, 1882, show that the State at the close of that term held in custody 1330 convicts, of which 685 were worked within the penitentiary building, in wood and iron manufactures; 28 were employed in cutting a railway tunnel; 34 at work on a farm; and 500 in the several coal mines. Nearly half were scattered over the State in branch prisons, housed in stockades and worked in gangs, surrounded by guards. The number held in custody has since increased to some 1500 convicts.

In the other States the system and plan of convict leasing corresponds with that of Tennessee. In North Carolina, at first the penitentiary proper and its interior industries were conducted under public account, but the prison buildings, poorly constructed, were inadequate to the sheltering of the increasing number of inmates, and subsequently the greater number were scattered about in companies, under lessees, working on railways and wagon roads. In this, as in other States, the self-supporting idea seems to be the paramount consideration; the warden's report in one instance citing the fact that "the convicts have earned $678.78 more than the prison department has cost" under a preceding State administration.

In South Carolina the system varies slightly—only those convicts being hired out who are sent beyond the prison walls; and the prison proper is under a full corps of State officers, and conducted on the public account plan; but here too, as elsewhere, the consideration of self-support obtains and the leasing system is dominant, a penalty attaching to the lessees for each escape of a prisoner.

In Georgia the lease extends to twenty years. The convicts are consigned to three prisons in different parts of the State, to each of which there are attached branch camps.

In Texas $10,000 is the State's annual share in the profits of the leasing system, but the working of the convicts remote from the penitentiary is condemned, and efforts have been made to bring the management into conformity with a statute requiring as many convicts as possible to be worked within the prison walls. The Texas board of managers has intimated its aversion to the system, and it would have been abolished in all probability, but for the necessity of making the prison labor pay the expenses of the prison.

A report of the prison management in Alabama, in 1880, closed with the statement, that "the future of this institution is brighter than its past," a statement seemingly inspired by the announcement immediately following, that it had paid $48,000 into the State Treasury; but a report to the succeeding administration two years later, closed with a statement condemning the leasing system as "a reproach to the civilization and Christian sentiment of the age."

Virginia for several years held to the contract system, but later changed to the lease system under pecuniary considerations. The prison having become over-crowded, a large number of convicts were leased to railway contractors.

In various States leased or hired convicts are employed in different occupations, varying according to the exigencies of the local situation. In Kentucky the law prohibits the employment of convicts in mines, but they are leased to contractors engaged in building railways. In Arkansas they are worked in coal mines, and in Georgia in both coal and iron mines and in stone quarries. In Mississippi there are no mines of any sort, and the leased convicts are worked on levees and in planting cotton. Texas has the largest prison population, and Tennessee the next largest; while Georgia has twice as many as Maryland. Prison reports generally show a heavier mortality list in the branch prisons, or camps, than the penitentiary proper.

The bulk of penitentiary convicts are received from the ranks of men untrained to any mechanical art or handicraft. The men with trades either keep out of prisons or appear in a marked minority, although there is usually a sufficient number of skilled mechanics in prisons to constitute a teaching force. But most of the convicts are worked in mines and on railways and levees, in

obedience to a popular clamor, especially from artisans and mechanics, against their employment in the field of skilled mechanics. Aside from this, the first general opposition to the leasing system was based upon political considerations rather than upon those of humanity or upon resistance to encroachments on the rights of general free labor. Mine operators claim that they introduce convicts, not for economy, but because they cannot rely on the free miners. On the other hand, the miners claim that coal cannot be put on cars for less than one dollar a ton by free labor, while with hired convicts it is put on at eighty cents per ton. The cost of feeding and guarding a convict is estimated at as high as twenty cents a day. The minimum task for each convict is four tons of coal a day. The price of coal varies, but putting it at the lowest wholesale price, say $2.50 per ton, it appears that the convict is made to earn the corporation ten dollars per day, less twenty cents. The free miner's wages are fixed at fifty cents per ton, which at four tons a day would net him two dollars, a sum that he does not always get in cash. At some of the camps there are free stores, and it is not an unusual thing to see a sign on a door reading thus: "Lard-oil fifty cents cash; sixty cents in scrip." This is significant when the mining company's checks are only worth eighty cents on the dollar, except on the last day of the month. In the convict mines the lessees are turning out coal at the rate of 1½ cents per bushel. For years the average price has been two cents per bushel, and that price holds in the free mines yet, but the owners have to compete with the leased mines, and they claim that they cannot do it successfully and pay half a cent more on the bushel. Therefore, they say, the free miners are compelled to come down to 1½ cents a bushel,—in plain terms, to put themselves on a level with convict rates.

Thus, the issue is between the brawn of free labor and the sweat of criminal slave labor, or, as tersely expressed by one advocate for the abolition of the lease system, it is "an irrepressible conflict, on one side of which is arrayed conscience and the civilizing instincts of humanity; while on the other side is the plea of poverty raised in behalf of two million people in a State of the most varied wealth-producing resources of any on the North American Continent, and this plea nursed by the blandishments of a corporation, the most powerful of its kind in the Western hemisphere." Per contra, a prominent mine owner and operator is authority for the statement that the cost of coal, with convict labor

abolished, would advance twenty-five cents per ton, and the cost of fuel would not only be thereby increased, but the burden of taxation to maintain the prisons as well. This latter burden, however, is one sustained by some thirty odd other States and by other governments.

In the abolition of the system of leasing convicts, the State Governments now practising it will be confronted with a perplexing economic problem. Of the various proposed methods for profitably and legitimately utilizing convict labor, that one, suggested in some of the States, of employing the labor, under State supervision, in the improvement of the public highways seems to meet with most favor. It is contended that by such internal improvements the industrial enterprises in the mineral and timber districts will be benefitted as well as the agricultural interests, and that, in the enhanced values of lands supplied with good roads the State would be compensated in increased revenues from the increased assessments for taxation. The profit of the leasing system is questioned by statisticians and economists who take into the account the losses of convicts by the more frequent escapes from the camps of the lessees; the proportionate larger mortality list; and the absence of proper reformatory influences upon convicts, from time to time released by expiration of sentence, to be turned loose upon the community.

The alleged inhumanity of the leasing system is based upon the assumption that the convicts, removed from the direct supervision and care of the State, and left to the care of soulless corporations or selfish individual lessees and sub-lessees, are subjected to neglect or exposure, if not the cruelty and oppression of irresponsible task masters. Of specific cases of cruel treatment it would be difficult to procure evidence, but it would seem an unreasonable supposition that the lessees, having a considerable pecuniary interest in the bodily capacity of the convict to perform labor, would be unmindful of his physical condition or the preservation of his health. No specific cases of cruelty on the part of lessees or their agents are alleged, unless it be in the matter of scanty and unwholesome food and inadequate shelter. The circumstantial evidence furnished in the comparative mortality as between inmates of the Penitentiary building and those of the remote camps and stockades is, in itself, a silent indictment against the latter. The higher death rate of the outside prisons, however, is ascribed to exposure and lack of the medical attention and hospital accommodations of the city prison.

The lessee is, presumably, concerned in the preservation of the health of his hireling from motives of self-interest, while the State's care of the prisoner's health is, or should be, influenced by higher moral considerations. If this moral consideration is secondary with the original lessee, it is certainly not improved by the abominable practice of indiscriminate sub-leasing.

Aside from sanitary and pecuniary considerations, the whole system is revolting to the moral sense of the community and of the American people generally, and the demand for its abolition is most earnest in those communities where the system prevails. How soon the reform may be brought about is not to be determined definitely; but that it is only a matter of time when the lease system must go, is conceded.

So far as Tennessee is concerned, where has recently arisen a conflict between the free miners and the lessees of convict labor, bringing the issue sharply to public attention, there is at least a prospect for an attempt to reach a speedy solution of the question through legislative action. The Governor of that commonwealth has issued his proclamation calling the State Legislature into extraordinary session "to enact, amend or repeal such laws with reference to the penitentiary of the State, as shall be deemed promotive of the public good, as the leasing, working and safe-keeping of the convicts; the removal, rebuilding and enlargement of the State prison; the consideration of measures that will reduce the contact and competition of convict with free labor to the minimum and conduce at the same time to the humane treatment of the convicts, and also, the policy of increasing and defining more fully the powers of prison inspectors." Just what can be done to remedy the evils of the leasing system and to minimize the competition between convict and free labor, is the perplexing problem which the Executive of the State has referred to the legislative department. If the latter is equal to the emergency, and will impose the requisite taxation for the removal, rebuilding and enlarging of the State Penitentiary building, it may possibly find employment for the convicts that will not come into competition with free labor. By the same method, they may be supplied with the means to indemnify the present lessees if they consent to the abrogation of their contract, which has yet some four or five years to run before the expiration of the lease. Judged by the past record of the Legislature, there is not much to encourage the hope that such a policy will prevail at the extra session which begins next month, but the force of public opin-

ion may impel the Legislature to prompt action. Whether or not the lease system be abolished at this extra session, or during the session of a new Legislature to be chosen next year, the consensus of opinion in Tennessee is decidedly in favor of working the convicts in the penitentiary proper and under immediate State supervision.

In any event, the consensus of opinion seems to favor the abolition of the leasing system, upon moral and economic grounds. This sentiment has been growing for several years, and the system was perhaps a foredoomed institution even before the crisis of a threatened civil conflict brought its evils to a suddenly awakened sense of the dangers of its prolongation, just as the foredoomed extinction of the slavery institution found its climax in a conflict between free and slave States. The question, while more or less a political one, is in no sense a partisan issue. The best thought of all parties is averse to it. It can no more withstand the enlightenment of the nineteenth century than could the slave trade of the century preceding.

DEVELOPMENT OF THE DYNAMITE GUN.

By B. C. Batcheller, S. B., M. E.

THE armored ship and the use of high explosives in projectiles at long range, are the two significant contributions made by American genius to naval warfare. The history of the *Merrimac* and the *Monitor* suggested the reconstruction of modern navies with more powerful guns; and now, before a great battle on the seas has put to a test the new tactics and the new forces involved in the general improvements, the invention of the Pneumatic Dynamite Gun adds a perplexing problem to the game of destruction.

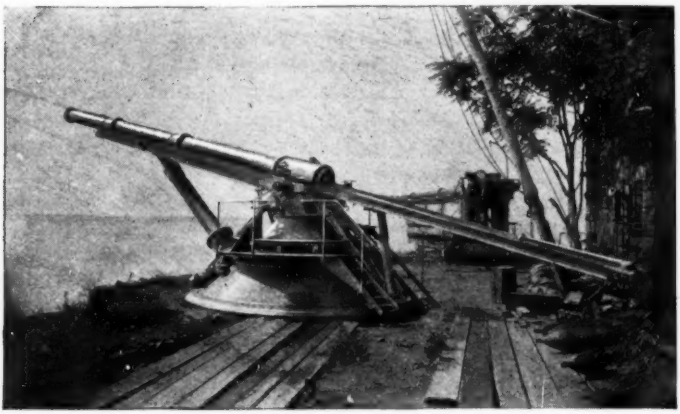
No one knows what will be the outcome of the next great collision of the navies; and it is possible that doubt will not be answered in the remaining years of the Nineteenth Century. Much has been written, picturing forth the details of that great combat. In the way of romance, Stockton has written his "Great Syndicate War," and hardly less fanciful, but confined to the actual forces, is the recent book by an English officer describing "How we Fought the Battle." It is certain that the deeds of heroism and self-sacrifice that it will call forth the requirements of clear judgment and undaunted courage from every participant, stir the imagination even now. The changes in the conditions are too numerous to recall in the preliminary survey. Since the days of Trafalgar, steam has taken the place of sails. The guns are worked mechanically. A single shot will do the fatal work of a former broadside. The old pictures representing the hand to hand conflict when ships were grappled, can never be painted again in the times to come, for the rapid-fire guns would annihilate the bravest body of tars long before it could tread a hostile deck. No wooden hulks will be seen floating half sunk in the sea and half seen in the murk of powder, with men clinging to the scattered spars and hatchways. Vessels of iron have a terrible alacrity in sinking, and the ram crushing into the sides of a ship has a merciless power. In fact, even the defensive features of this new warfare have elements of terror in them. The sums that have been spent on these untried navies are enormous. Of course their destructive possibilities are amazing.

It is not a settled matter that a small boat, not much larger than a harbor tug, armed like the *Vesuvius* with dynamite guns, could annihilate the most formidable armored vessel afloat; but such a result is the aim of all experiments with high explosives. It will be seen further on in this article what has been ascertained as to the destructive power of the shells and their accuracy of range. It is almost useless to speculate on the uses to which the pneumatic principle of firing may be put. Of course, it will not be confined to the special boats like the *Vesuvius*. It will, however, in all probability, be years before a high explosive is found that can be fired safely from an ordinary gun with the charge of powder commonly

THE 8-IN. PNEUMATIC GUN, BUILT IN 1884, AT FORT LAFAYETTE, NEW YORK HARBOR, FOR SEVERAL YEARS.

used; while compressed air offers distinct merits and conveniences.

Since high explosives of a stable and reliable form were first discovered, many attempts have been made to use them for the bursting charge of shells, fired from powder guns. Small charges were sometimes successfully propelled, when no detonator was used, but they produced no greater effect upon the target than an equal charge of gunpowder, because high explosives cannot be properly detonated by the shock of impact alone. They require some form of detonator, which is of necessity sensitive, and which in consequence will not stand the heat and shock of firing. These difficulties led to the adoption of compressed air as a means of propulsion. Its application could be controlled, making the shock



THE FIRST 15-IN. PNEUMATIC GUN, BUILT IN 1888. MOUNTED FOR EXPERIMENT AT FORT LAFAYETTE, NEW YORK HARBOR.

of the discharge a minimum, and it had the additional advantage over gunpowder of being cold instead of hot.

The present gun is the outgrowth of years of experience and experimenting. No one man can be pointed out as its sole inventor. Experiments were first made by Mr. Mefford in 1882, with a 2-inch gun of very simple construction. It consisted of a seamless brass tube, supported upon a T-iron and mounted upon a tripod. Air, compressed to the moderate pressure of a few hundred pounds per square inch, was stored in a small cylindrical wrought iron reservoir, having a hand-valve at one end for controlling the escape of air to the gun. The hand-valve was connected with the breech of the gun by a flexible rubber tube which could be disconnected for loading. The projectiles consisted of a piece of brass tube from twelve to eighteen inches in length, having a heavy pointed iron or brass head in one end and a long piece of wood projecting out of the other, forming a tail like that of a rocket. The tube was filled with explosive. Made in this form, the centre of gravity was quite near the front end and the resistance of the air against the wooden tail, served to keep the projectile always tangent to the trajectory. After the shell was placed in the barrel and the rubber tube connected to the breech, the gun was discharged by opening the hand-valve at the reservoir and closing it again as soon as possible after the shell had left the muzzle, in order to save

the air. Ranges of more than a mile were obtained with this crude arrangement.

The results with the 2-inch gun were so promising that a 4-inch gun was next constructed after a design made by Mr. Geo. H. Reynolds. It was in many respects similar to the 2-inch gun, but differed from it in this essential feature, that it possessed an automatic firing valve which could be regulated to allow any given amount of air to escape from the firing reservoir. For example, the valve could be set to open and remain open for a time that would allow the projectile to move three-fourths the length of the barrel, and then close, causing the air then in the barrel to act expansively, like steam in the cylinder of an engine working with a "cut-off." In other words, the regulation of the valve was a regulation of "cut-off." This gave a means of varying the range without changing the elevation of the gun, analogous to varying the charge of power in a powder gun. It also used the air in the most economical manner. In place of a rubber tube connection between the reservoir and the gun, iron pipes were used with swinging joints. The projectiles were similar to those employed with the 2-inch gun.

The next gun, constructed in 1884, was an 8-inch, designed by Mr. Nat. Pratt, similar in principle to its predecessors, but very different in arrangement. The barrel was 60 feet in length, made of wrought-iron lined with brass, in four sections, bolted together

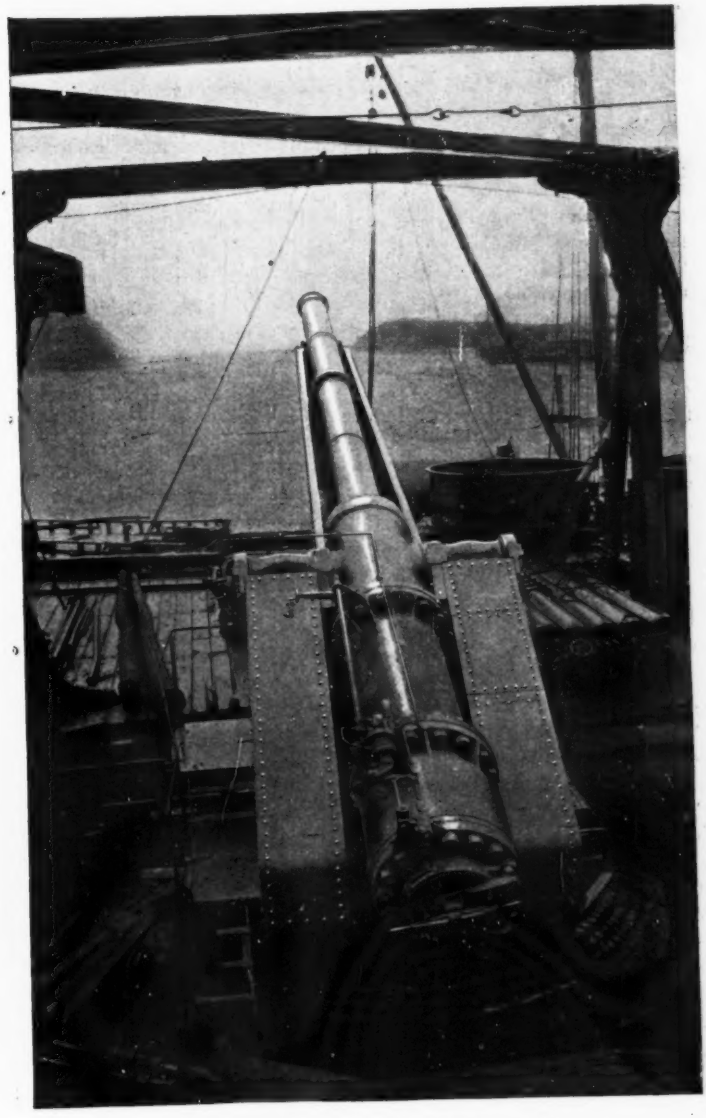
THE 15-IN. PNEUMATIC GUN, DESIGNED BY CAPT. JOHN RAPIEFF, MOUNTED ON A TEMPORARY FOUNDATION FOR TESTING. AFTERWARDS MOUNTED AT SHOEBURYNESS, ENGLAND.

and mounted on a wrought-iron truss. The trunnions were at the breech and elevation was given by a hydraulic cylinder and plunger. The firing valve, similar in principle to that used on the 4-inch gun, was located at the right trunnion. The firing reservoir consisted of eight wrought-iron tubes, 12 inches in diameter and 25 feet long, all connected together by the large hollow castings that supported the trunnion bearings. The gun was traversed and elevated by hydro-pneumatic power ; air from the firing reservoir was admitted to a chamber nearly filled with some liquid, such as alcohol and water. This liquid served to operate the hydraulic cylinders. Projectiles were now designed entirely of metal. In place of the wooden tail a small brass tube was used, with steel blades or vanes attached to it, similar to a screw propeller, but much longer in proportion to its diameter. These blades or vanes presented the necessary resistance to the air, and at the same time caused the projectile to rotate.

Numerous and extended experiments were made with this gun. The most noted was the destruction of the schooner *Silliman*, in New York Harbor, September 20, 1887. This schooner was 90 feet long, 25 feet beam, anchored stern on, at a distance of 1864 yards from the gun. The shells used contained 55 lbs. each, of explosive gelatine. The first round fired went to the left. The second struck just astern of the schooner, exploded in the water, broke off the main-mast and injured the stern deck. The third round burst directly underneath the vessel and broke her up completely. Two other effective shells were fired in the wreckage but they were not needed.

On September 30, 1887, ten dummy projectiles were discharged from the same gun in 10 minutes and 45 seconds, each weighing 140 lbs. These and numerous other experiments demonstrated conclusively that large charges of high explosive could be thrown with accuracy and rapidity to considerable distances, with perfect safety to those operating the gun, and that they could be exploded in an effective manner either against a target or in the water. These results also led to the construction of much larger guns, having barrels 15 inches in diameter. One sea-coast gun was built and tested at Fort Lafayette, New York Harbor ; and three, of special design, were built for the *Vesuvius*, now in commission in the U. S. Navy. In each of these the principle remained unchanged but the details were brought to a higher state of perfection.

The guns of the *Vesuvius* are 55 feet long and 15 inches diam-

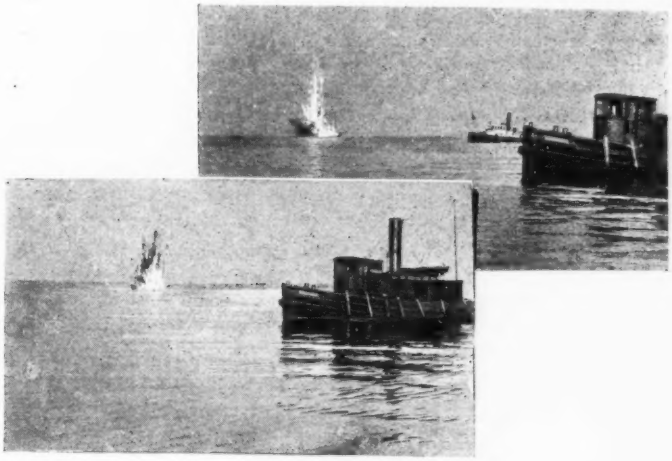


A TOP VIEW OF THE 15-I

eter of bore. They are mounted parallel with each other in the bow of the vessel, at a fixed angle of elevation of 18 degrees, their muzzles just protruding through the deck. They are trained by steering the vessel, and the range is varied by changing the "cut-off." Each has its own firing valve, and all are connected to a common firing reservoir. A five-chamber revolver under each gun contains the projectiles. A section of the barrel next to the breech is pivoted and drops down in line with one chamber of the revolver. A hydraulic ram pushes the projectiles from the revolver into the movable section of the barrel, which is then brought up into line with the rest of the barrel and locked. Additional projectiles are stored in three revolvers located just forward of the revolvers used in loading. These two sets of revolvers are placed in line, so that shells can be quickly passed from one to the other. The loading is done entirely by hydraulic mechanism, operated by a single man at each gun. The guns are discharged by levers in the conning tower. On the official trial fifteen shells, each weighing about 500 lbs. with a capacity for 200 lbs. of explosive each, were discharged in 16 minutes and 11 seconds. All these facts are significant of the usefulness of the gun, and are far in advance of the experiment with the *Silliman*.

It was now decided that, while guns for use on board ships might be of various sizes, guns for sea-coast defense should be 15-inch. With this size projectiles can be thrown weighing 1000 pounds and containing 500 pounds of explosive. The type of gun finally adopted for sea-coast defense was designed by Captain John Rapieff, formerly an officer in the Russian army. The first one—built by the West Point Foundry, at Cold Spring-on-Hudson—was sold to the British government. It was set up and tested by them at Shoeburyness, England, during the winter and spring of 1891. It was the good fortune of the writer to be present at the interesting and successful tests.

The gun in general appearance resembles a power gun, having the axis of its trunnions at or near the centre of gravity of the barrel. The barrel is of cast-iron, smooth bore, made in three sections, the walls being about 1½ inches in thickness. The "breech-plug" or "gate" is simply a convex disk, with a tooth-shaped or interrupted flange. The disk swings outward on a hinge and when closed is secured by turning it a small fraction of a revolution. In the rear of the trunnions there is an outer casing about the barrel which conveys the air from the hollow trunnions where



THE SECOND AND THIRD SHOTS AT THE SILLIMAN.

it enters, to the breech. The main firing valve is located at the breech. It consists of a large sleeve sliding on the outside of the barrel, in its closed position, covering six ports leading into the barrel, just in rear of the projectile. The movement of this large sleeve valve is controlled by a much smaller auxiliary valve upon the outside of the gun. To discharge the gun the auxiliary valve is opened with a lever, located in a convenient position at the left trunnion. After doing this, the operator has no further control over the valve as it is entirely automatic in its action. The time regulation of the valve—in other words the "cut-off"—is governed by the time required for a fixed volume of air to flow through an orifice. The size of this orifice fixes the time, and this is adjusted by a micrometer screw. Thus by simply turning a hand-wheel the range can be varied from a few hundred yards to several thousand without changing the pressure of the air or the elevation of the piece.

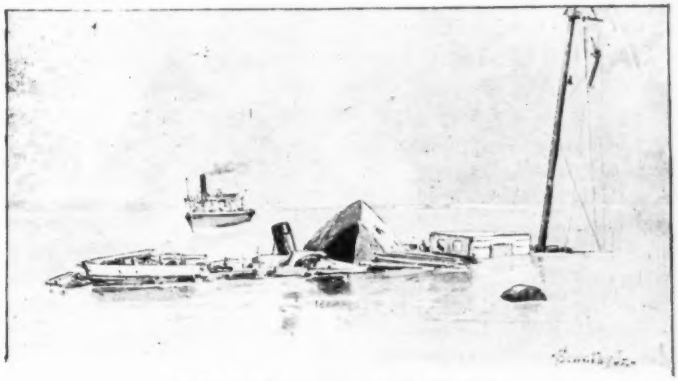
The carriage is box-form, built up of wrought-iron plates, stiffened and fastened together by angle-irons, channel-irons, I-beams, etc., riveted together. It is mounted on a "circular bed plate," and contains the traversing and elevating gear, air pipes, etc. The gun is traversed and elevated either by hand cranks at the side or by an electric motor inside the carriage. This motor is controlled by

a rheostat and switch on the firing platform, at the hand of the officer sighting the gun. The use of power greatly faciliates the handling of the gun and makes it possible for a very small squad of men to load and fire very rapidly. The gun can be traversed 360 degree and elevated 35 degrees.

The firing reservoir consists of six wrought-iron tubes, 16 inches in diameter and 25 feet long, placed in the ground below the gun, three on either side. The air from them flows up through the central pivot, which has a large "turning-joint," to the trunnions, where it enters the casing about the barrel. Since the air is only stopped off by the main firing valve, these pipes and casing are under pressure all the time when the gun is being used. The air pressure is usually 1000 lbs. per square inch. In addition to the firing reservoir under the gun, air is stored at a much higher pressure, usually 2000 lbs. per square inch, in tubes located at any convenient place some distance from the gun. This is called the storage reservoir. Air is drawn from it after each shot to restore the pressure in the firing reservoir. The air is pumped into the reservoirs by a steam air compressor. Several different forms of this machine are to be found in the market at the present day. The principle is the same in all but they differ considerably in arrangement of parts and mechanical details. To obtain such high pressures as 1000 and 2000 lbs. per square inch, the compression usually takes place in two or three successive stages and is cooled between each stage as well as during compression. Since the volume of the air diminishes as the pressure increases, the cross-sectional area of each successive cylinder is made smaller. One form of air compressor much used, has a steam cylinder and two air cylinders arranged in line, on a bed plate, with a common piston rod. The steam cylinder is at one end. Air from the atmosphere enters the large middle cylinder and receives one-half of its compression, then passes through a series of copper pipes surrounded by cold water, to a second smaller cylinder, where it receives its final compression. The air cylinders are always water-jacketed to keep them cool and prevent the destruction of packings. The chances of the air compressor getting out of order and thus disabling the vessel in action are remote.

Two types of projectile are now used, in various sizes, known as full-calibres and sub-calibres. The full-calibre, which fills the bore of the gun completely, consists of a light, strong case containing the explosive, fuse, etc., with a small tube in the rear sup-

porting the rotating blades or vanes. The case or body consists of a steel or iron tube $\frac{1}{8}$ to $\frac{3}{16}$ inch thick, closed at the front end by a brass conoidal-shaped head and at the rear by a hemispherical base casting of bronze. The base casting has a socket in the centre to attach the small tube that supports the rotating blades. Eight blocks of vulcanized fibre, on each end of the shell, centre it in the bore of the gun and prevent the metal parts of the shell from touching the bore, causing thereby, friction, heat, vibration, etc. Shells for a 15-inch gun are usually about 10 feet long, overall,—the body being about 7 feet and and the rear extension 3 feet. These have a total weight when filled of 1000 lbs., and contain 500 lbs. of high explosive. The fuse is placed either in the point or base according to its design. The sub-calibre projectiles are smaller in diameter than the bore of the gun, and have no rear extension carrying rotating blades. The blades are attached directly to the body, near the rear end. They occupy a portion of the space between the body of the shell and the bore of the gun, at the same time serving to centre the rear end of the shell in the bore. The front end is centred by four wooden blocks which drop off as soon as the shell leaves the muzzle. They are held in place, during movement through the bore, by pins entering into the shell. A wooden disk or gas-check is placed in rear of the projectile filling the bore completely and preventing any escape of air. The body of the projectile is made up similar to the full calibre except that the charge only fills about three-fourths of it, the remaining space at the rear being left empty. This is done to keep

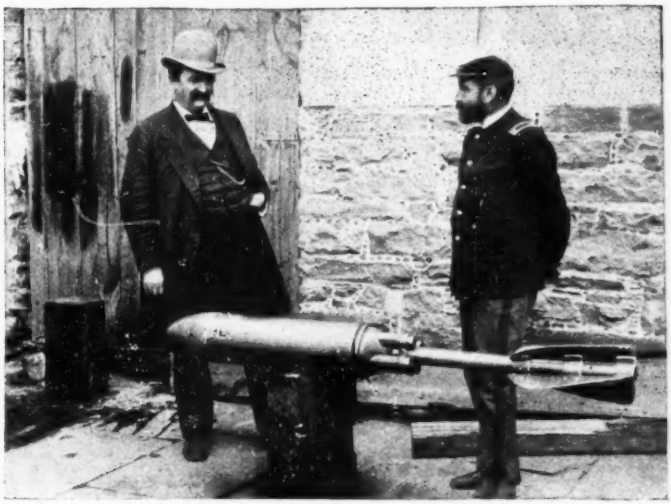


WRECK OF THE SILLIMAN AFTER THE EXPERIMENT.

the centre of gravity forward of the centre of figure and so maintain steadiness of flight. Sub-calibre shells 6 inches in diameter and about 6 feet long, weighing, filled, 150 lbs., contain a charge of 50 lbs.; those 8 inches in diameter, 6 feet 5 inches long, weighing, filled, 300 lbs., contain a charge of 100 lbs.; and those 10 inches in diameter, 7 feet 8 inches long, weighing, filled, 500 lbs., contain a charge of 200 lbs.

Fuses of various kinds have been used, the most noted being Captain Zalinski's electrical fuse. It consists of two fuses, one to act instantaneously upon striking a solid target, such as the hull of a ship; the other to act upon entering the water, either instantly or after some seconds of delay. The first may be called an impact fuse and the second an immersion fuse. The former consists of a battery containing liquid, ready for action, connected through a "low tension" primer. Upon striking the target, the circuit is closed and the primer exploded. This explodes the detonating charge of dry gun-cotton or dynamite and that in turn explodes the whole charge. In case the shell misses the target and enters the water the immersion fuse acts. This is similar to the other except that the battery contains no exciting liquid—is perfectly dry. As the shell enters the salt water the battery becomes wet and active, which immediately causes explosion unless a delay is desired, in which case a powder train is used. Mechanical fuses have been sometimes used. These generally act by impact either against a solid target or the water. An ingenious fuse of this class was designed by Mr. H. P. Merriam. One of its most peculiar features is a small wind-mill at the point of the shell, which unlocks the firing hammer as the shell passes through the air. It has two sets of caps, one intended to act when the shell strikes a solid target, the other when it strikes the water. The water enters an opening in the point and presses a plunger backward, driving the caps against the hammer which in this case is a steel ball. When a solid target is struck the point of the shell is crushed in, thus firing a set of caps arranged inside. Delay action can be given by a powder train.

The range of the gun depends upon the pressure of the air, the point of "cut-off," the elevation of the piece and the kind of projectile used. Using 1000 lbs. pressure per square inch, a maximum "cut-off" and an elevation of 35 degrees, the range of a full calibre projectile weighing 1000 lbs. is about 2700 yards or $1\frac{1}{2}$ miles; that of a 10-inch sub-calibre, weighing 500 lbs., is about 4000 yards



George H. Reynolds. Capt. E. L. Zalinski.

A FULL CALIBRE PROJECTILE FOR AN 8-IN. GUN.

or 2¼ miles; and that of an 8-inch sub-calibre, weighing 300 lbs., is about 5000 yards or 2⅞ miles. The muzzle velocity of these shells varies, of course, under different conditions, but it usually lies between 450 and 800 feet per second, depending upon the air pressure, "cut-off" and weight of shell.

The projectiles are not designed for penetration, but at Shoeburyness a 10-inch sub-calibre, weighing 500 lbs., was fired into a butt of sand, situated 600 yards from the gun, and it penetrated 47 feet. The accuracy of fire is very remarkable, even when compared with modern rifles. The following table is a record of the ranges and deviations obtained at Shoeburyness, England, during the experiments of the British Government:

8-INCH SUB-CALIBRES. INITIAL PRESSURE, 1000 LBS. WIND 8 FEET PER SECOND, FROM "4 OCLOCK."

Number of Round.	Elevation.	Range.	Deviation from line of fire.
1	20°	3647 yards.	17.2 yards left.
2	"	3643 "	20.8 " "
3	"	3647 "	18.6 " "
4	"	3640 "	22.6 " "
5	"	3644 "	21.2 " "

It will be noticed that the five shots all struck in a horizontal rectangle 7 yards long by 5.4 yards wide. They fell at an angle of about 28 degrees and buried themselves in the level sands of the beach. The average deviation of 20.1 shows the combined effect of the wind and the natural drift of the projectiles. In shooting at a target allowance would be made for these disturbing influences by pointing the gun a little to the right or left of the "bull's-eye." The above experiments were made to test the accuracy of the gun by showing how closely the shots could be grouped together. For this reason no wind or other allowances were made.

The effect of explosion is a very interesting feature of all experiments with high explosives. This was emphasized by the destruction of the schooner *Silliman* in 1887. She was totally destroyed by two shells containing only 55 lbs. of nitro-gelatine. We can only wonder what would be the effect of shells containing 500 lbs. Unfortunately, at least for our knowledge on the subject, very few experiments have been made with large charges of high explosive against iron-clad men-of-war. According to General Abbot, a charge of 100 lbs. of nitro-gelatine in the water would be effective against a first-class war vessel at a distance of 21 feet. Probably a charge of 500 lbs. would be effective at 50 feet or even a greater distance under some favorable conditions. The effect of such charges on deck would certainly be most destructive, if we can judge by the accidents that frequently happen in quarrying and mining.

The Pneumatic Gun with its projectiles filled with large charges of high explosives—speaking more correctly its ærial torpedoes, for they should be classed as torpedoes—is especially adapted to the protection of harbors and channels, replacing, to a large extent, the complicated system of submarine mines and auto-mobile torpedoes launched from the shore. A special design of gun, known as the revolver type, designed by Captain Rapieff, is adapted to mounting in the bow of torpedo boats. This gun has a barrel 15 or 20 feet long, 9 inches in diameter of bore, placed in line with one chamber of an 8-chamber revolver. The firing valve is placed just in the rear of the revolver, and is connected by two pipes directly to the firing reservoir. The gun has a permanent elevation of 30 degrees, and is trained by steering the boat. The vessel goes into action with the chambers of the revolver all filled so that no loading has to be done except to turn the revolver one chamber after each shot. This makes it possible to fire, as rapidly as two shots

per minute, shells carrying 100 lbs. of explosives. Guns of this type will doubtless prove useful when placed in the bow of large vessels. They are admirably adapted for counter-mining. As time goes on no doubt many other uses for this weapon will be found—some have already suggested themselves—for the extensive experiments that have been made, both in this country and in England, prove the entire practicability of the system.

A 10-IN. SUB-CALIBRE PROJECTILE.

THE WORK OF OUR WEATHER BUREAU

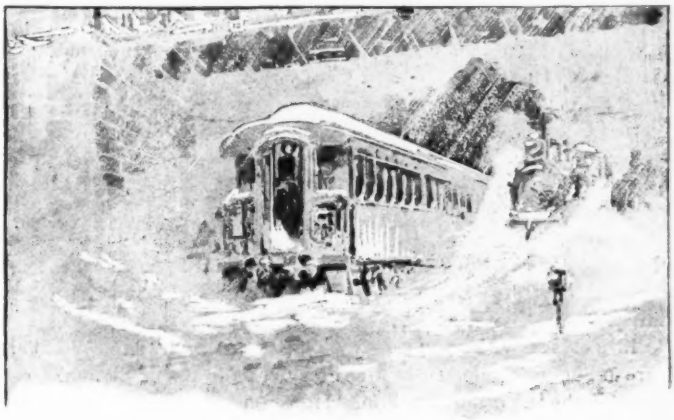
By Sergt. E. B. Dunn.

THE fact that storms in this country travel from southwest to northeast was first observed and established by Benjamin Franklin, and this elemental principle suggested the feasibility of making known advancing weather conditions. The demand for the establishment of points of observation became urgent, for the benefits to be derived were of a practical kind, and were of concern to commerce and agriculture, while the theorists foresaw the development of a science.

Many years passed, however, before legislation was brought to bear in the matter. In the latter part of 1869 Mr. David M. Stone, then president of the Associated Press, and now editor-in-chief of the New York *Journal of Commerce*, in company with several other prominent men, solicitous of advancing the commercial and agricultural interests of the country, busied themselves with Congress, and on February 9, 1870, that body passed a "joint resolution, to authorize the Secretary of War to provide for taking meteorological observations at the military stations and at other points in the interior of the continent; and for giving notice on the northern lakes and seaboard of the approach and force of storms." The measure passed both Houses of Congress without a dissenting vote. Gen. Albert J. Myer, chief signal officer of the army, was assigned to the charge of this new branch of work by the Secretary of War, Hon. Wm. W. Belknap. The duties now imposed upon General Myer were distinctly novel. The precedents established in other countries in the way of procedure, as well as in theory, were not altogether applicable to our own, and many obstacles presented themselves at the beginning. The problem was not a trivial one, but called for serious and conscientious work. The general interest

evinced and the acts of scientific men, exhibited an expectation of results which the most experienced physicists knew must be sparingly promised. The service was capable of an indefinite extension. The benefits to be obtained, if success could be arrived at, were of a kind to tempt ambitious experiment and energy. The Signal Corps, which was thus called into existence ten years before the establishment of the weather service proper, found its duties united with a scientific as well as a military branch of the Government. Officers and men were detailed from the line of the army to aid in this important work. The enlisted force was increased from time to time until 1878, when the number was fixed at 450. The entire force up to 1890 consisted of 1 brigadier-general, 14 second lieutenants, 125 sergeants, 20 corporals and 175 privates. During the past fifteen years the men employed in the Signal Service were not taken from the line of the army, but were, for the most part, graduates of our highest colleges, entering upon their duties after passing both mental and physical examinations.

As soon as a system of observations was decided upon, stations were opened in the larger cities throughout the country. On October 10, 1870, were established the station at New York and twenty-four others, covering principally the border of the Atlantic and the lakes, and including a few scattered over the vast interior. The office in New York was started at 57 Wall Street, and on July



A BLIZZARD SCENE IN THE GRAND CENTRAL YARD, NEW YORK.

25, 1871, was removed to the Equitable Building at 120 Broadway, where it has since remained.

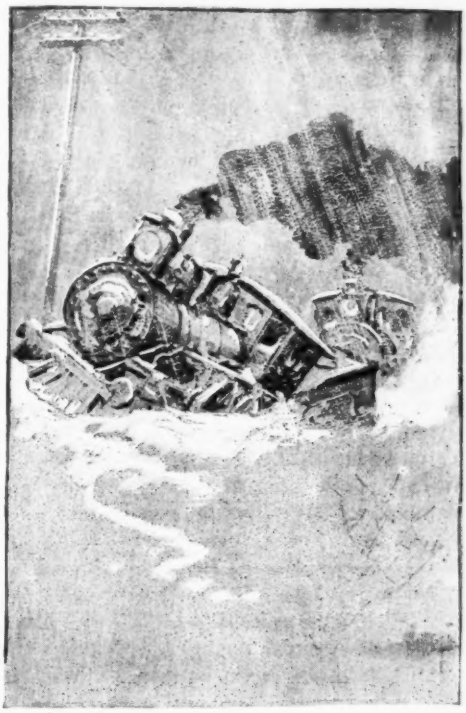
Regular telegraphic reports of storms and of local weather conditions were first attempted November 1, 1870. The first issue to the country of "Weather Probabilities" as they were then called, began February 19, 1871, and were issued thrice daily until within the past three years, when two daily issues were made to meet the needs of the Press and by way of reducing the expense of telegraphing.

Prof. Cleveland Abbe, on January 3, 1871, was assigned to the department as Meteorologist and assistant to the Chief Signal Officer, and associated with Prof. T. B. Maury on June 18, 1871. Under the guidance of these able men the weather service started upon its successful career. It was during 1871 that Gen. A. W. Greely was assigned (while second lieutenant) to the duties of making "Weather Probabilities." With the exception of his three years of voyage in the Arctic regions, he remained with the Bureau to the time of its recent divorce from the Signal Corps, when he left the service with a high and honorable record, having filled almost every office under its control with credit to himself and honor to this branch of public usefulness.

The Signal Corps, continuing in charge of Gen. A. J. Myer, gradually increased in magnitude and efficiency up to the time of his death, August 24, 1880. General Myer was succeeded by Gen. W. B. Hazen, who died on January 16, 1887, after a period of five years as chief, during which time many important changes and improvements were made. Gen. A. W. Greely then succeeded to the office and held it up to June 30, 1891, when by an Act of Congress, approved October 1, 1890, the Weather Bureau and Signal Corps were made separate bureaus; the former being placed under the control of the Secretary of Agriculture, and the latter being retained under the control of the War Department, with Gen. A. W. Greely as its chief. The Signal Corps at the present time comprises one brigadier-general, one major, four captains, four first-lieutenants and fifty sergeants, who perform purely signal and military duties.

Prof. Mark W. Harrington was placed in charge of the Weather Bureau and was selected by the President for his many qualifications for the important position. He is a man of broad and practical ideas, and besides being possessed of executive ability, he is a thorough master of Astronomy and Meteorology. He was born near

Sagamore, Ill., in 1848, and is descended from the earliest settlers of New England. Graduating from the University of Michigan in 1868, he became instructor of Biological Science in that institution and remained there until 1870. He then received a commission from the U. S. Coast Survey to take Astronomical Observations in Alaska. In 1876, he pursued further studies at the University at Leipsic, and during that year received an appointment as Professor of Astronomy and Mathematics in the school of "the Chinese Foreign office" at Pekin. In 1879 he was at the head of the Astronomical observatory of the University of Michigan at Ann Arbor. He was made about this time a member of the Royal Meteorological Society of London. Since 1884 he has edited the *American Meteorological Journal.* Professor Harrington is distinguished for his culture and his force as a writer. Under his management there is no question as to the steady advance of the new bureau in its science as well as in its efficiency.



ON A SNOW-DRIFT.

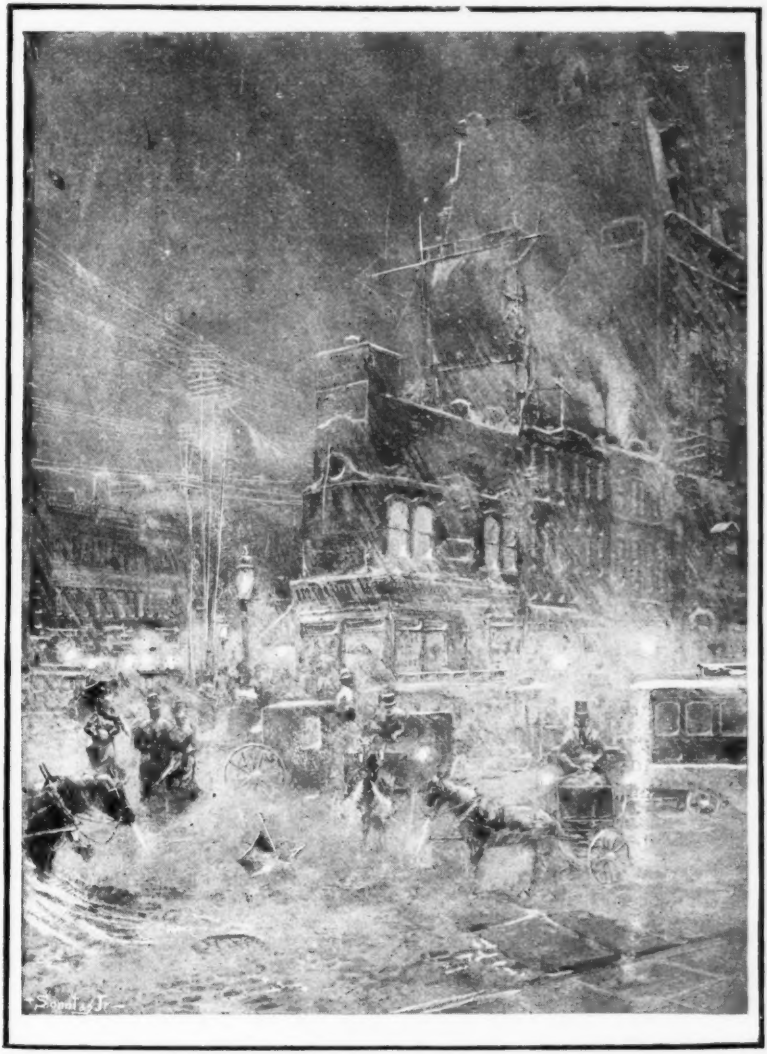
Among the many projects Professor Harrington has in contemplation, is that to have stationed over the country, especially about twenty of the larger cities, the most skilled observers to make *local* forecasts for their immediate vicinity. It has long

been Professor Harrington's opinion that, with the aid of the daily weather maps a local forecaster makes more accurate predictions than those sent out from Washington. He further says that this must necessarily be the case, other things being equal, if the local forecaster has at his disposal all the information available for the general forecaster. At present the local forecasts are being made at Boston, Buffalo, Chicago, Cincinnati, Cleveland, Detroit, Galveston, Milwaukee, Nashville, New Orleans, New York, St. Louis and St. Paul. The local forecast officials are instructed to make their predictions each morning and night from the observations and reports received from the various stations throughout the country, and these are to be amplifications or additions to those issued from Washington, but to be more in detail.

Professor Harrington says that the successful prediction of weather is, for the most part, the result of information and practice; but it seems also to be due to a peculiar sagacity which it is impossible to define. It is a matter of mental make-up, which cannot be foretold nor supplied when non-existent.

In former years, before weather science had reached the high standard of the present day, it was not a very difficult matter to obtain a high percentage of justification. At that time predictions, or "probabilities" as they were called, were made for a large territory, embracing several States; the New England, Middle and South Atlantic States covering the entire sea-board, with very few other divisions to take in the entire country. Rain, or fair weather, predicted for any one of the sections was easily verified over such a vast area. Now the country is divided into States and parts of States covering such a small area that a more exact calculation is called for. For instance, if the forecasts officer says "Rain for eastern or western New York" it must necessarily rain .01 of an inch before his prediction is verified; and if he says "Fair weather," and it should rain .01 of an inch, he loses his percentage. With the local forecaster it is even more difficult; for his territory is so small that all his tact and skill must be used to enable him to be successful. Especially must he be ever watchful on the Atlantic coast, for lying between two great storm tracks, as New York and Boston, the weather conditions are at times very complicated, and as he is without any reports from the eastward he must be more than ordinarily careful to be successful.

A forecaster must be a man of steady self-reliance, and, indeed, of courage, for there is nothing more trying to a forecaster than



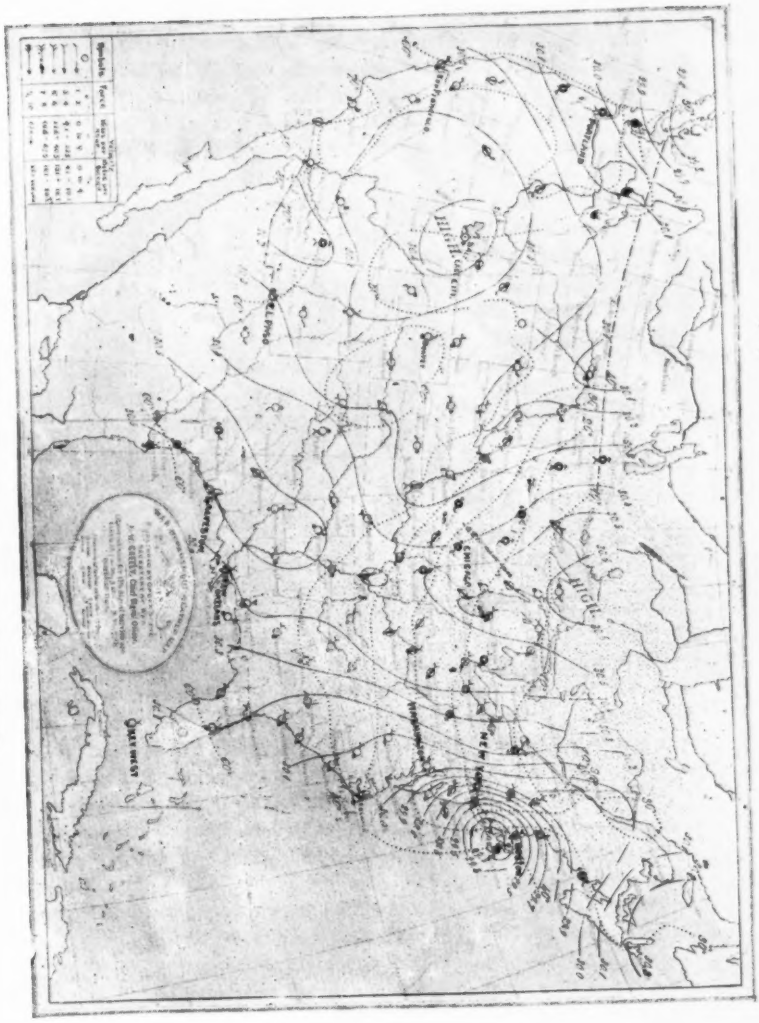
SCENE AT THE JUNCTURE OF FIFTH AVENUE AND BROADWAY, NEW YORK, DURING A STORM.

adverse criticism. Failures may often be due to timidity in expressing one's opinion for fear of failure. Such men do not serve long. Moreover, sound practical meteorological knowledge serves better than theory, and is the best means of success. This, in no degree, excludes the factor of science.

Under Professor Harrington's management the climate of the various States is to receive special study. As it is the average weather or climate of any particular section that determines the agricultural capacity, it is therefore necessary for a farmer to understand the climatic conditions under which he is laboring before he can work intelligently for the best results. The seasons of drought are to receive careful attention, as well as cloud-bursts and torrential rain; the inequality and distribution of rainfall; temperature variability; the question of relative or absolute humidity; hot and cold waves; "Northers" of Texas, and many other subjects bearing relation to climate and agriculture.

A system of a more general distribution of weather data and reports is being perfected, which will enable farmers and others interested to obtain the latest and best information at the earliest possible moment. Professor Harrington believes in a wide dissemination of all such meteorological data, and thinks that all reports should be placed in schools and libraries throughout the country. He also remarks that the general weather service has heretofore devoted itself rather to the interests of commerce than to agriculture. This has been because the needs of commerce could be more completely supplied by general predictions, and also, because those interested in commerce are congregated in the great cities, and can be more easily reached. The weather service has not, however, failed to try to benefit the farmers, as its accurate predictions of frosts and floods for the cotton region, and its studies of tornadoes, thunderstorms and cold waves clearly show. These warnings have saved losses that are incalculable. But of the many important investigations and improvements to be made in the new Weather Bureau, considerable time may elapse before the results can be fully realized.

The science of Meteorology is yet in its infancy. The study of the laws of nature, and the general increase of knowledge, have during the past century lessened the influence of astrologers and empiricists, and have convinced all reasonable minds that the study of atmospheric phenomena, on an adequate basis, will eventually make meteorology as clearly understood as are astronomy, chemistry, electricity and many other branches of science.



THE U. S. WEATHER BUREAU MAP OF THE GREAT BLIZZARD OF 1888.

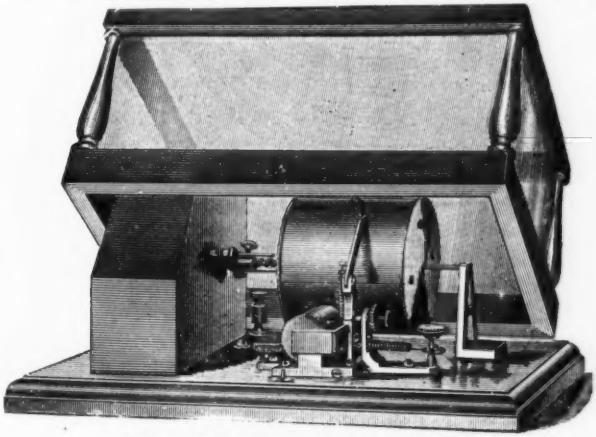
Weather services of foreign countries, established years prior to our own and on a more substantial footing, supplied with the finest instruments, capable of vast experiments, have come to realize the fact that the Weather Bureau of this country furnishes to the people at large more valuable information through the daily press in a shorter space of time and with more accuracy than all the foreign services combined. As all storms in leaving this side of the ocean travel slightly to the north of east, they are felt in a few days in Europe. To enable foreign countries to receive the benefit of our reports, cablegrams are sent daily from the chief of the Weather Bureau to Paris and thence to London, giving the location and severity of the high and low pressure storms traversing our country. These cablegrams are posted at the various exchanges throughout England and France, and masters of vessels are thus enabled to leave port with a full knowledge of the weather conditions they are likely to encounter; knowing a storm is travelling east over their track, they can make a course more to the north or south and avoid a rough passage.

The real value of our Weather Bureau is but little understood. Every class of people enjoys the benefits to be derived from the daily reports found in the press; the farmer being guided in planting and harvesting; the shipper of perishable goods paying no little heed to the warnings of cold or warm waves; the people living in the low lands along our great rivers having more than once saved their lives and property in consequence of their heed. The tobacco, cotton and grain interests are made a special feature of weather reports, and the "weather market," based on reports sent to them, governs many transactions covering millions of dollars. The maritime interests are kept fully informed of the location, movement and severity of all storms, and but few captains leave port now without a full knowledge of the weather conditions that they are likely to encounter. In the general mind the thousands of lives that are saved annually are never entered to the credit of our Weather Bureau for advice given.

There is a recognition, however. One captain of our "Pacific Mail" entered the New York office of the Weather Bureau not long ago, to thank the service for the valuable information given to him before sailing on his previous voyage. He said he had followed the advice relative to a cyclone advancing toward this port as he was about to leave. He was instructed to slow down and keep close as possible to shore in order to avoid the fury of the storm; he did

so, and the storm centre passed to the east of his vessel, wrecking everything in its reach. He added, "I feel it my duty to my wife and children, the company I represent, and the passengers of our line, to call at this office for the advice of the service before leaving port;" and he never fails to call. Such instances of gratitude are so few that they are hardly worth the mention. The true, practical value of our Weather Bureau is, therefore, not heralded in a commensurate way.

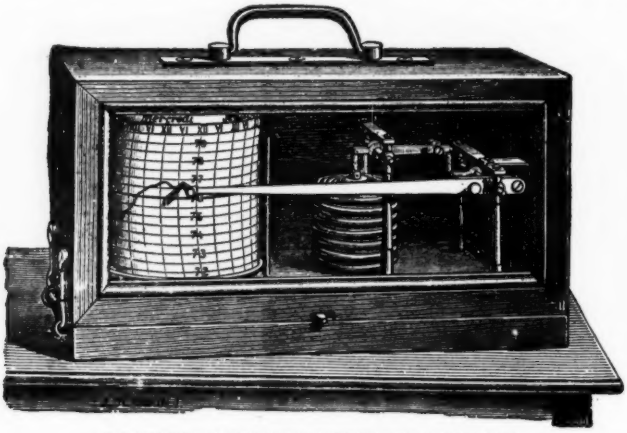
The system of observation and weather reports comprises much careful labor. Observations are taken each day at 8 A. M. and 8 P. M. After the observation is completed, a report made up in a



SELF-REGISTER FOR RECORDING WIND VELOCITIES.

brief telegraphic cipher is sent from at least one hundred and sixty stations to the chief office at Washington, and is transferred to all the stations throughout the country over the various circuits leased from the Western Union Telegraph Co. for certain hours each day. This report contains the reading of the barometer, reduced to sea-level, also corrected for temperature; the currents and minimum temperature in the morning or current and maximum temperature at night; state of weather; direction and velocity of wind; dew-point and rainfall. As soon as these reports are received at the different stations, they are translated and entered on a stencil; "isobars" or heavy black lines are drawn for every tenth of an inch in pressure, connecting all places sending the same reading. "Isotherms" or temperature lines are also drawn for every ten de-

grees, connecting all places of equal temperature ; and in this way the storms of high and low pressure are located. The curvature of the heavy lines shows the probable course of the storm, and the



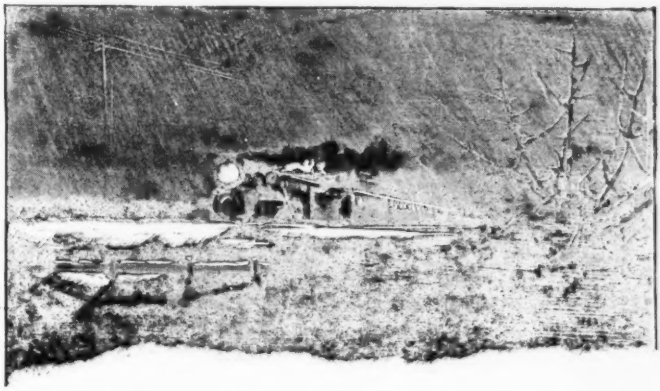
SELF-RECORDING BAROGRAPH FOR REGISTERING AIR PRESSURE.

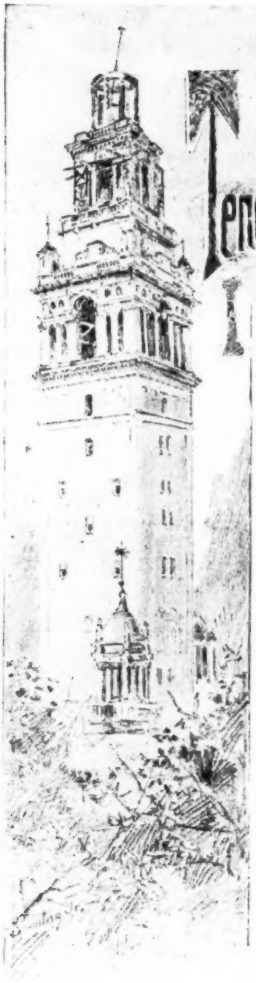
dotted or temperature lines the movement of cold or warm waves. This map when completed is used, in addition to local phenomena, for making the forecasts sent out to the daily papers by the Associated and the United press. They are issued for the country in general from Washington, and for the larger cities from local offices designated for that purpose. The maps are posted in post offices, exchanges, ferry houses, elevated station platforms, and in many conspicuous places for the benefit of the public. The reports are greatly sought after, and closely watched by the various branches of trade, being easy of comprehension after a few moments study, but at a glance they look very complicated, much like a problem for the scientist. It is hoped that before many years, with the steady advance of the age, every college and school in our land will use them in the daily course. Every man, woman and child could then have enough weather knowledge to be his or her own "Weather Prophet."

The accompanying chart of the memorable "Blizzard" of March 12 and 13, 1888, will serve as an illustration of locating a storm centre, and give an outline of the radius of one of the most severe storms that has been observed in this country. The lines of pressure surrounding the "Low" are closely drawn, showing the

severity of the storm by its steep gradient. The storms that cross our country are divided into two general classes; one in which a deficiency of pressure occurs, commonly known as "Low," and another which appears in the form of an area of excessive pressure known as "High." Low areas travel across the country by diverse paths, their average direction being a little to the north of east, with a velocity of about five hundred miles daily. From all sides of the "Low" the winds blow spirally, inward and upward, with force proportional to the barometric gradient. The "Low" is generally preceded by cloudy and rainy weather and high temperature. High areas generally follow the low areas, about one-half of them move east from Minnesota to New England; the others from the northwest south to Texas, then to the eastward, affecting the Southern States; and with advancing high areas the weather clears and becomes cooler. When a high area passes over the New England coast, it frequently occurs that rain falls over the New England and Middle Atlantic coast. The circulation of wind from a high area is a reverse to that of the low, the winds blow out from the centre, corresponding to the movements of the hands of a watch.

The self-recording barometer shown herewith is of the latest pattern used by the Weather Bureau for recording the variations of atmospheric pressure, which are automatically recorded by a pen attached to an arm connecting with the lever of the vacuum chamber and moving over a paper scale fastened upon a brass cylinder, it records accurately the air pressure by expansion and contraction of chambers.





Tendencies in Recent Architecture.

By Bayy Ferree, School of Arch. - Univ. of Penn.

IT has been frequently pointed out by European observers that America is yet too young to have buildings of historic or antiquarian interest, that we suffer from a superabundance of newness. The criticism is not without point, yet recent advances in architecture in all our large cities have been so rapid, that if we do not possess structures antiquarianly interesting we have an abundance far behind our present necessities, and both structurally and artistically quite out of touch with the needs and ideas of the day. The buildings of New York which were once the wonders of America are so no longer. Each day witnesses new changes, fresh progress, incessant alterations. In a single year nearly $75,000,000 has been spent in new buildings in New York City alone, and a very large amount must, in addition, have been expended in altering old structures to conform to current necessities. So rapid have been the changes of business and manufacture

that the life of a building has become a serious consideration with property owners. In a few years the most advanced of our present model buildings will be behind the times, and fresh expenditures will be called for if they are to retain their position as the finest products of modern architecture.

From every point of view this changeableness is an advantage. We obtain greater conveniences. Methods of heating, lighting, ventilation, and other fundamental necessities receive more intelligent treatment with a corresponding advantage to the tenant. Business is accomplished with less fatigue and more comfort. New industries are created by the demand for fresh appliances which the new conditions call into existence. A powerful impetus is given to the building trades which is reflected in increased prosperity in other industries. Finally, the appearance of our streets is improved or injured, as the taste of the builder or owner is developed or not. It is this last question which will be considered in this paper, because while architecture does not consist in the placing of attractive façades to structures, this part is of great importance, and is, perhaps, less understood and appreciated than any other phase of architectural art.

If variety were a prime essential of architecture New York would stand an admirable chance of gaining the first prize in an architectural competition. In the golden days of architecture, when it was in every sense an art, no one thought of asking in what style a particular edifice should be built, because there was but one to use. In the modern world the style is a highly important element, and many hybrid mixtures are served up to the public as trustworthy examples of the historical styles, but which often only exhibit the lack of knowledge of the designer. New York is richly endowed with varied examples. The Tombs is in an alleged Egyptian style. The United States Sub-Treasury may be taken as an illustration of a classic effort. A new church has been begun in the upper part of the city in what is said to be Byzantine. The Casino is interiorly a really excellent example of Moorish decoration. There are innumerable Gothic churches of all periods and of all possible variations, and the Renaissance furnishes the model for many public and private edifices. With few exceptions these buildings illustrate so many changes in public taste. Architecture is not with us as with the Greeks, or as it was in the Middle Ages, a matter of national feeling and expression ; we are quite without that ethnic homogeneity which alone can give us a national architecture.

A CORNER OF THE NEW HOTEL IMPERIAL SHOWING THE MAIN ENTRANCE.

That which passes for architectural taste, but which is really not far removed from architectural caprice, changes every few years, and with almost as much rapidity as fashion in dress. Sometimes it is for the better ; sometimes, unfortunately, it is not.

Various names have been invented to distinguish the latest contributions to architectural art. as modern Romanesque, modern Gothic, modern Renaissance, Renaissance modified, Gothic modified, Renaissance-Gothic modified, and so on indefinitely. The names are only interesting as indicating the tendency in modern architecture to copy art forms without an appreciation of their meaning. For nothing can be more senseless than to borrow a variety of parts from a corresponding number of buildings, arrange them in one design, and then rest satisfied that a new architecture has been invented which is worthy to rank with pure Gothic or high Renaissance. It would be as hopeless a task to catalogue these combinations as it is to admire their eccentric originality.

But while all this is quite true there is another side to the question. Styles in modern architecture may not be interpreted in the best or most successful way, but the public craving for change has in many instances resulted in a marked improvement in the appearance of our street fronts. The older buildings not only appear to be out of date, which they really are, but suffer artistically in comparison with the newer ones. Structures in the Renaissance which were fashionable a few years ago, such as the Royal Insurance Building in Wall Street, the Brown and the Drexel buildings in the same locality, the New York Life Insurance Co.'s Building on Broadway, the National Park Bank and many others of the same kind, compare very unfavorably with more modern buildings. Many notable changes have been made in Wall Street, and structures like the United States Trust Co., the Mechanics National Bank, and in a lesser degree the Bank of America, show an improvement in public taste. The Bank of America, though less successful than the others, favorably contrasts with the older grey granite structure adjoining, whose sombreness seems better adapted for a prison than for an active place of business.

In many recent façades the windows are the single feature of the design, and the wall space is reduced to lines of separation between them. In the Electrical Exchange Building, the new building at the corner of Twenty Third Street and Fifth Avenue, the Mercantile Library, and numerous others the architecture is only a frame work to hold the glass of the windows. Utility is a safe criterion by

THE NEW "CENTRAL" BUILDING, LIBERTY AND WASHINGTON STREETS.

which to measure architecture. but the most zealous utilitarian may well regret the tendency to make our buildings walls of glass with scarcely sufficient visible support to keep them upright. One of the most successful handlings of the window problem is in the new building of the Union Trust Co. The three great recesses which form the feature of its façade are admirably managed and exceedingly effective, though perhaps some exceptions might be taken to the manner in which the windows fill them. The design somewhat recalls the Times Building, but is much more impressive and vastly superior to it.

Two motives, the recess or arcade and the basement furnish the basis of most recent façades. Neither of these ideas is new, but

they are now so generally employed as to be characteristic of modern buildings. The arched recess, which only differs from the arcade in being employed where the front is too short to admit of a succession of arches, and which is usually filled with tiers of windows, came into use as a relief to the monotony of a series of windows without any architectural grouping. Few large façades are now undertaken in which it is not employed in one shape or other. It is a conspicuous element in the designs of the Columbia Building, the new Delmonico's, the Corbin Building, the Times Building, and, in a very unfortunate manner, the newly erected upper half of the Western Union Building. In the Central Building, the Stokes Building, and the new structure at the corner of Eighteenth Street and Broadway, the recess becomes an arcade or series of piers enclosing the windows. The London and Lancashire Building in Nassau Street, the Edison Building in Broad Street, and the building at Twentieth Street and Broadway are somewhat noticeable as containing neither the arched recess nor the arcade.

Vertical relief being obtained by means of the recess, horizontal variety is sought in the basement and cornice, strings or friezes. A favorite design is a basement with cornice or attic and an intermediate structure of a different material, which finds typical illustration in the new building of the Methodist Book Concern. The new Delmonico's is a brick superstructure resting on a brown stone basement of unusual severity which has no connection with the part above. The Central Building also has an unusually high granite base. Architecturally a basement requires to be more than simply built of a material different from the main portion of the edifice. When several storeys, as in the Lincoln Building on Union Square, are built of a material different than that chosen for the upper part of the structure, the lower portion ceases to be a basement. Façades of this class are seldom homogeneous and lack unity essential in all good designs. The four lower stories of the new building at the corner of Eighteenth Street and Broadway are, like the Lincoln Building, of a different material than the upper floors, but the design is less heavy and obtrusive than in the older structure. Both the arched recess and the basement are excellent elements in their way, but the difficulties of properly proportioning them renders the wisdom of their employment sometimes questionable.

Not only does the necessity for the admission of light limit the architect in preparing his design by calling for the greatest number of windows as well as the largest, but it prohibits any massing of

THE "JUDGE" BUILDING, FIFTH AVENUE.

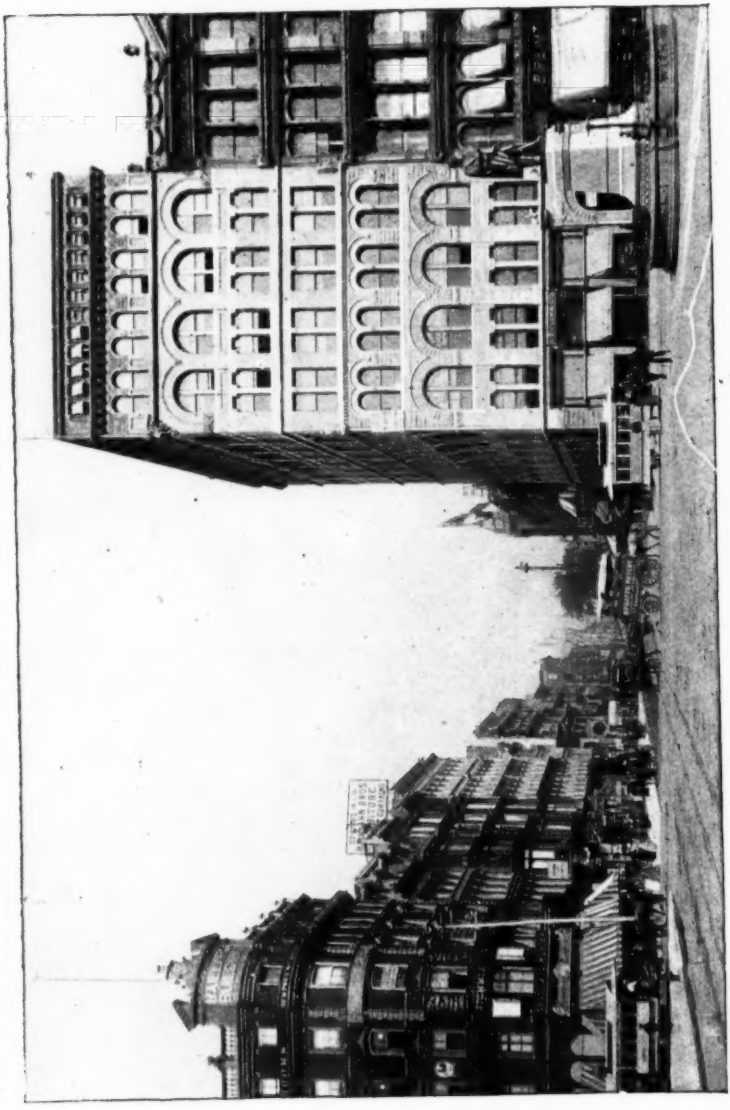
the parts which would give variety by projections or recesses. Either of these expedients would result in a darkening of adjacent portions or a positive loss of room with a diminution of revenue. In office buildings, the almost single resource remaining to the architect has been the use of a few bold piers, which with or without connecting arches form the solitary relief to a façade of windows. Much the same condition may be noted in hotels. The evolution of the hotel in New York has been not less remarkable than that of the office building. The difference between the Astor House in its early days and the now demolished Merchants' Hotel was not less great than that which separates the Astor House from the new hotel projected by the present Mr. Astor. Architecturally the Astor House is absolutely devoid of interest, and there is no better indication of recent improvement in architectural taste than a comparison of its monotonous walls with even the faulty designs of more recent erections. The Fifth Avenue Hotel belongs to the same old order of things, though of somewhat more ambitious effort. Here

the architect selected a single idea and repeated it *ad infinitum* around the entire structure. The enormous size of the hotel gives it a certain dignity to which the individual parts do not entitle it.

The example of the Hotel Beresford to the contrary, it is safe to say that no more hotels will be built in New York on the obsolete lines of the Astor House or the Fifth Avenue. Indeed, the day for more recent structures like the Grand Hotel, the Victoria Hotel, the Hotel Brunswick, the Gilsey House, and the thoroughly featureless Hotel Bartholdi, has also passed, and a new era begun in hotel architecture as well as in office buildings. And this movement is not less commendable because it has failed in some instances or because many of the efforts of the new school err as much on the side of an attempted ornamental aspect, as the older buildings did in ignoring it. The Hotel Imperial shows a change in the public taste that would have been deemed impossible a few years ago. The design is not pleasing or even good, but it is distinctively superior to many of the older structures of its class. It is noteworthy that the façade does not, as is too often the case, consist of an interminable row of windows. The fronts exhibit an unusual amount of wall space, and it is to be regretted that with these opportunities the architects did not produce a more effective building.

The Holland House, on Fifth Avenue, is a further illustration of the difficulties imposed by current conditions. The front on Thirtieth Street is entirely without relief save that given by two or three friezes or string courses, and the lines of the windows. The main front on Fifth Avenue has scarcely more variety, but some variety is obtained by slightly projecting windows. In this design every inch of street front has been included within the area of the building. There are no obnoxious windows looking into other rooms, but the size of the building renders the result somewhat monotonous, and the richly-carved entrance porch becomes a conspicuous feature of the whole.

The impracticability of massing the façade in an effective manner has impelled architects to exhaust their ornamental ideas upon some one single part which is thus often lifted into undue prominence. The entrance, a porch, or a window, is frequently utilized for this ornamental treatment. A slightly recessed archway filled with richly decorative carving is the chief feature in the façade of the Hotel Imperial. But the most noteworthy example of this system of designing is the new Madison Square Garden. It would



THE LINCOLN BUILDING, UNION SQUARE, CORNER 14TH STREET AND UNIVERSITY PLACE.

require more space than can here be given to examine it in detail, but it may be remarked that the chief fault consists in the ornamental parts being too rich, the plain portions too plain. The distribution of ornament and blank wall is not judiciously managed, as, to note but a single instance, where a piece of plain brick-work is introduced between the ornaments of the arches of the arcade and the frieze above. The ornamental window or centre piece in the middle of the main façade is without connection with the rest of the edifice, though the chief element in the design. This is the more noticeable because there was no special occasion for the Garden presenting an unbroken front.

Less improvement is to be noted in the design of apartment houses than any other class of large buildings. In the cheaper grade houses attempts at architecture have not yet advanced to a point worthy of notice, and are more evidence of a lack of general appreciation of art than any feeling for it. It is scarcely to be expected that buildings devoted to the necessities of the masses should exhibit any special architectural merit, but it often costs less to produce a beautiful building than an ugly one, and a better disposition of materials in these edifices in many instances would have given much better results at no greater cost. The older, more expensive apartment houses have few points of merit : they are overgrown piles of stone, brick, and iron with very little architectural feeling. Nothing could well be less interesting than The Florence, and the enormous size of The Chelsea fails to give its endless succession of identical windows any dignity or interest. The Dakota, facing Central Park at Seventy-Second Street and Eighth Avenue, is more modern in design than the majority of buildings of its class, and its almost bald simplicity has points of interest not possessed by the over-ornamented flats of Fifty-Ninth Street, while it is unquestionably superior to the newer and adjoining Hotel San Remo.

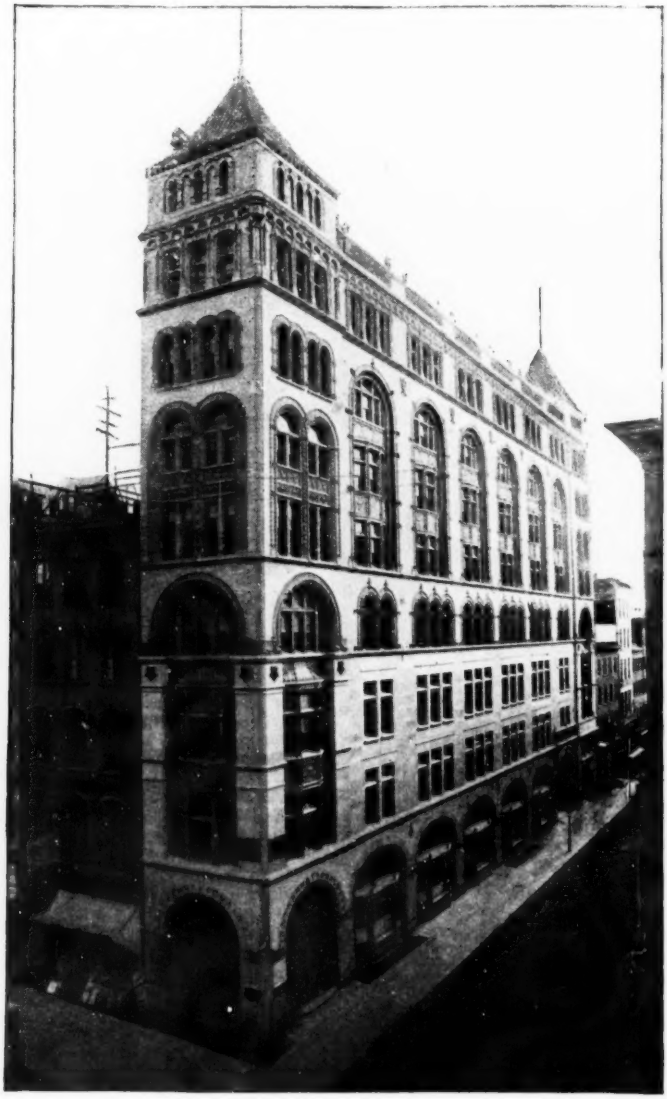
Dwelling houses, which of course are more numerous in a city than any other kind of building, exhibit the same influence of new ideas. Unfortunately the very number of dwellings operates against them disadvantageously in the matter of architecture. The individual house, erected and occupied by the owner, is by no means the thing of beauty it should be nor is it always the acme of comfort which is supposed to be an especial characteristic of such dwellings. Architectural knowledge has not yet been sufficiently diffused throughout the community for the private resi-

THE WASHINGTON BUILDING—OVERLOOKING BATTERY PARK.

dence to be noted for its good taste or real art. City and suburban dwellings alike suffer from this, though possibly the latter are more affected since the builder in the country is not bound by the conditions which prevent the free exercise of individuality in architecture in the great cities. Yet, notwithstanding the many failures and the bad architecture of the new districts, there are unmistakable indications of a greater popular interest in architecture than has been manifested at any time in our history. People are no longer satisfied to live in a house which is one of a dozen duplicates, with no more variety than that afforded by a door and two windows on the first floor, and three windows on each succeeding floor. The monotonous appearance of our older streets, in which the similarity of the dwellings would almost reduce one to the expedient of marking special houses with chalk, a method which was productive of wonderful results in one of the tales of the Arabian Nights, has given place to a variety and mixture which, in its way, is almost as confusing as the sameness once universal.

The movement is best seen in the new districts, especially on the West Side of New York, which for several years past has been the scene of amost phenomenal building operations. Instead of the former system of rows, each dwelling a duplicate of the other, it is no unusual thing for a different design to be employed in each house, or at least in not more than two adjoining ones. The conditions under which dwelling houses are built and the uncertain state of our architecture are not conducive to long continued or widely distributed good work, and, doubtless, more astonishing designs can be found in the West Side district of New York than on any other spot on the globe. But, with all this, the streets are more pleasing than the old-style thoroughfares which are identical in plan and design from one end to the other. And they are especially important as showing an increased general interest in architecture. This covers a multitude of errors, for with the diffusion of knowledge and a better understanding of the nature and function of the art, there will come an abiding improvement in it, beside which our present efforts at advancement will appear small and mean, and seem as the product of an undeveloped people rather than the work of those who had the sum total of human knowledge and every available resource at their command.

But there is another side to the question, another aspect which is not all brightness and hope but dark enough to seriously call in question the future of American architecture. A number of in-



THE CORBIN BUILDING, BROADWAY AND JOHN STREET.

THE DAKOTA FLATS 72D STREET AND 8TH AVENUE.

stances have already been mentioned in which the difficult and unfavorable conditions under which buildings were erected, as well as the uses to which they are put, has hindered a freedom of architectural expression. There is an almost equally large number in which the best opportunities have been given and lost and errors committed which should have been impossible. The intrusion of engineering into the architectural field, and the handing over to engineers of the designing of architectural monuments has not always been a success, nor has improvement in design always kept pace with improvement in construction. It is a most admirable thing to construct a building well and in accordance with the most improved ideas, but it is not incompatible to employ at the same time an intelligent architectural design. A well drawn exterior will thoroughly express a well planned interior, and no matter how sound or advanced the construction may be, the building falls far short of perfection if the façade or visible architecture is not as thoroughly excellent as the internal construction and plan. And it may be remarked as indicative of the tendency of American architecture that the most important genuine advances it has made, has been in constructional devices rather than in the full understanding of its art possibilities.

This has unquestionably operated unfavorably upon the pro-

THE WINDSOR HOTEL, FIFTH AVENUE.

gress of architectural art, and to it, in a measure at least, is owing the innumerable lost opportunities in American architecture. There are many fine sites in New York on which really monumental and successful buildings might have been erected had the architect studied his environment. It has been well said that in cities environment can have no influence on architecure as it did have in the unhampered architecture of the past, but this does not imply that when an occasion does arise it shall not be utilized to the fullest extent. Few sites in New York have the advantages of that on which the Post Office has been erected, yet in few buildings have the architectural possibilities been more completely ignored. In-

THE METROPOLITAN OPERA HOUSE, BROADWAY AND 39TH STREET.

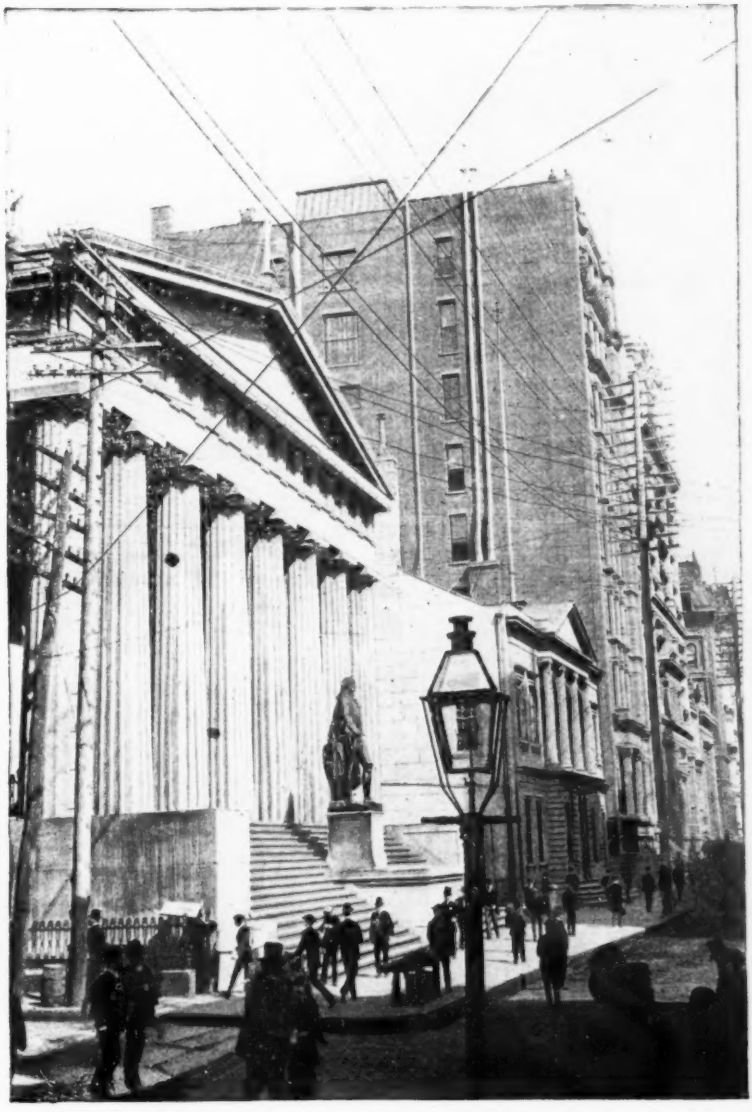
stead of a monumental structure standing free and alone at the junction of two important streets, on a lot entirely surrounded by open thoroughfares and with unlimited opportunities for obtaining good effect of light and shade, we have an inconvenient, awkwardly planned monstrosity which is the more unbearable from its conspicuous position.

The Metropolitan Opera House is another example of what might have been an imposing structure and is not. It was thoroughly in accordance with American utility to incorporate two

apartment houses in the design of a palace of pleasure, but the architectural effect is nevertheless disastrous. In the Madison Square Garden, which is perhaps the building which may be most readily compared with the Opera House, the ornament has been chiefly confined to a single front, the architects apparently being oblivious of the fact that the balance of the structure, much the larger part, as conspicuous to the public as the façade they have chosen, is almost devoid of even the baldest architectural effort. At the same time a comparison of the Metropolitan Opera House or the much superior Carnegie Music Hall with the old Academy of Music shows how very far we have progressed in architectural work.

In no case are neglected opportunities more noticeable than in buildings which occupy an entire block of ground or which cover sufficient lots to give the façade a breadth of some magnitude. A corner lot, especially, permits better treatment than where the building is confined between two others, yet there are many instances in recent buildings in which the very best opportunities have been allowed to pass unheeded. It is scarcely an exaggeration to say there is no more unfortunate tendency in modern architecture than the overlooking of a chance of producing good results when the conditions freely permit it.

No survey of recent progress in American architecture would be complete without taking into account its upward tendency. A high tall building is much less susceptible of intelligent and satisfactory treatment than a low broad one. Breadth adds dignity to almost any façade, while height causes an apparent attenuation of parts that is very unpleasant. There have been many exaggerated edifices erected in New York within recent years, and there will be many more in years to come. The high building has come to stay, and it behooves us to make the best of an unpleasant visitor. It was a great economic advance when it was demonstrated that in order to do a successful business it was not necessary to occupy the ground floor ; but however successful the tall building may be economically, however better adapted to business it may have shown itself than the low structures it supplanted, the architectural merits have not yet been made apparent. A most unfortunate inherent love for big things takes the place of art instinct in many American minds and enables a vast host of people, and well-informed ones at that, to see unsuspected and amazing merits in the tallest of structures. The popular mind often fails to distinguish any difference in meaning



THE SUB-TREASURY BUILDING, WALL STREET, CORNER NASSAU.

in the words "fine," "splendid," "big," "good art," "immense." Big buildings, like big men, command respect because smaller persons fear to take exception to them. It is, therefore, a great misfortune that a really desirable form of tall building has not yet been produced, if only that those who admire them may have something to worship worthy of admiration. The limitations of architecture are such, however, that it is almost impossible to obtain a satisfactory design for high and narrow fronts. Yet, there is no reason why the best should not be made of our materials.

Exaggerated edifices are bad enough in their way, but when no attempt is made to conform to the exacting conditions of height they become positive inflictions. The Tower Building, whatever may be its constructive merits, is one of the most conspicuous illustrations of this grade of work. In it the architect has exaggerated every line which tends to increase its apparent height and unfortunate narrowness and the result is almost painful. The Corbin Building further up Broadway is another very narrow front which the support of a long side does not render pleasing. It will, perhaps look better when the adjoining structures have been built up higher. Similar instances are the new building at the corner of 18th Street and Broadway, the Lincoln Building on Union Square and the Lancashire Insurance Building in Pine Street. In all the upward tendency has been greatly exaggerated, and one of the most difficult of architectural problems has been solved with indifferent success. There has yet been no instance where two extremely narrow buildings have been built adjoining one another, as this development of high structures with narrow bases is quite recent, but when the altitude of the buildings in all our principal streets has been increased to eight or nine and twelve storeys, as will unquestionably be the case in a few years, the architectural effect of the varied narrow façades, if they are composed on present lines, will be something to make the spirits of the air pause in wonderment in their flight. When the tall building becomes as universal as it is now exceptional, it will be impossible to get a good view of any building in the narrow streets.

HOW NIAGARA'S POWER WILL BE UTILIZED.

By Coleman Sellers, C.E.

THE practical minded man standing before Niagara Falls may well be pardoned for viewing that majestic and beautiful sheet of tumbling water as a huge and powerful mill-dam. His observation is entirely sustained by the facts in the case. The picturesqueness of the spot will be maintained by the two govern-

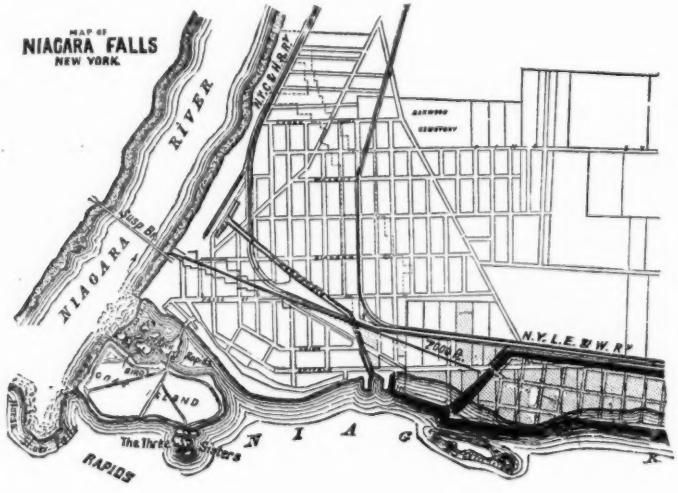
FAC-SIMILE OF THE FIRST ENGRAVING OF THE FALLS OF NIAGARA.
From Hennepin's "New Discovery," published in 1697.

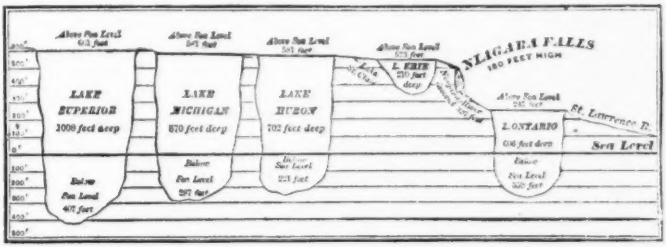
ments owning it, but, in the meanwhile, the Niagara Falls Power Company is constructing a tunnel that will divert from the Falls water sufficient to develop 100,000 H. P.

It takes most visitors to the Falls of Niagara some little time to realize that Canada lies due south as they enter Niagara Falls village by the railroad from Buffalo. This changed condition is owing to the sudden turn in the river. The Niagara flows west to reach the Falls, with the breast of the American Falls facing towards

the northwest, and the mighty cataract there pours its waters into a gorge narrowed to only a quarter of a mile wide, and then turns almost at a right angle and flows with a course east of north towards the Suspension Bridge and west of north from the Suspension Bridge to the great whirlpool. The points of the compass, so puzzling to newcomers, must be borne in mind in following a description of the place and of Niagara Falls as a source of power.

All rapidly flowing streams may be used for power where nature, as in this case, has planned a sudden fall or man has erected a barrier to form a pool of still water, which pool becomes the mill-dam or storage reservoir. From the mill-dam, canals or mill-races carry the water to the water-wheels, and from the water-wheels on a lower level a tail-race carries "the water that has passed" to the stream below the dam or fall. The water exerting its power through the wheel, has a power measured by volume, and by head, or the difference of level between the upper and the lower streams. The value of a water-power is somewhat dependent upon the distance the water has to be carried by canal from the stream to the mill or from the mill to the lower stream. The mills close to the dam may have the use of a head as great as the height of the dam-breast, and in some cases mills farther off may, by reason of the





continued fall of the river bed below the falls, find a greater head available at a considerable distance than close to the dam-breast. The head, however, may be lost by reason of the distance the water is carried before it is used, hence length of canal or mill-race is an important consideration in the value of water-power mill-sites. A mighty torrent such as at Niagara Falls, will yield power at any point in small amounts. Niagara Falls, however, considered as a mill-dam, has a breast nearly a mile wide; and water drawn from the pool above the rapids, must either be carried a mile or more to the wheel on the bluff below the falls, or have a tail-race dug through the rocks a mile or more long from a wheel operated near to the pool. The long tail-race is the foundation of the present enterprise.

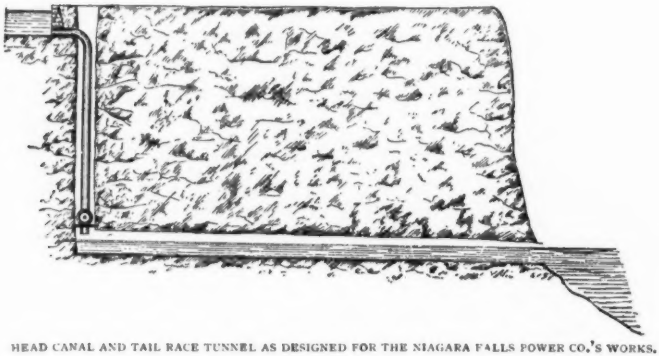
Among the various gaugings that have been made of the quantity of water that flows over the Falls, 265,000 cubic feet per second has been accepted as reliable, representing at 216 feet fall about 4,750,000 effective H. P. The quantity of water in the Great Lakes is so vast in amount that it could be gradually drained off and fed over the Falls at this rate of flow without any fresh supply from rainfall for at least a century. In other words, it would take, with a leakage of 265,000 cubic feet of water per second across the rocky barrier, 100 years to drain the upper lakes, were such a course possible. The outflow of the lake basin is about half of its rainfall, and the volume of the water in the lakes including Lake Ontario is thought to be about 6000 cubic miles.

The water that issues from the bluff below the mills at Niagara Falls has been called the Bridal Veil. This veil represents a loss to the Falls proper of 800 cubic feet per second, which loss, added to the 800 taken by the canal, and 100 by other users, points to at least 1700 cubic feet per second having already been taken without perceptible decrease in the torrent. The present

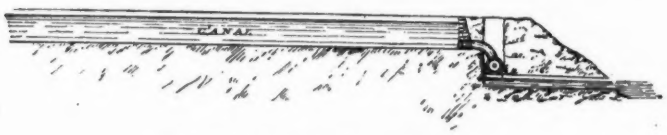
enterprise will take but an insignificant portion—not more than four per cent.—of the water that passes over the crest.

The theoretical value of the water that passes over the crest of this mighty dam has been represented as requiring all the coal that is now being mined in the world daily burned as fuel to make steam sufficient to pump back the same quantity of water. All the industries of America could be operated by this power, if it could be wholly transmitted.

In Switzerland, where coal mines do not exist, human ingenu-

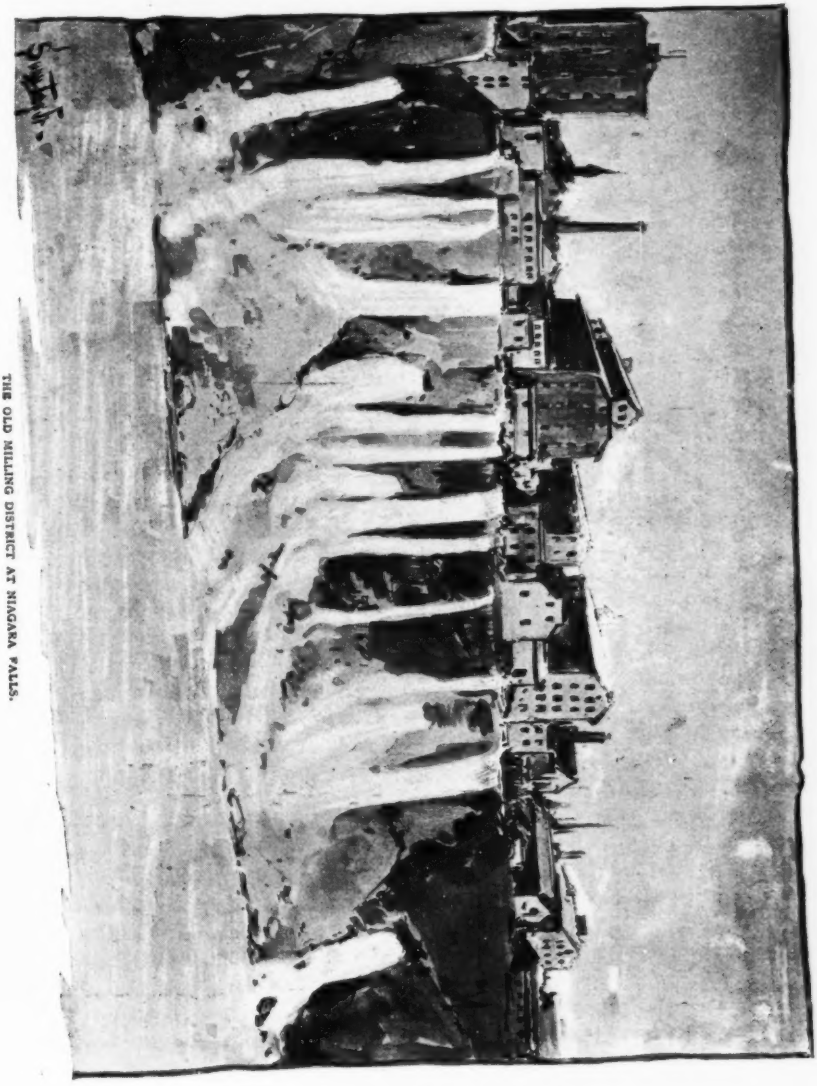


HEAD CANAL AND TAIL RACE TUNNEL AS DESIGNED FOR THE NIAGARA FALLS POWER CO.'S WORKS.



HEAD CANAL AND TAIL RACE AS ORDINARILY BUILT.

ity has been exercised to develop the power of the waterfalls. The engineers expended much ingenuity in transmitting the power from the waterfalls to the distant factories. Their pride has been in wire rope transmission, by means of which power was sent a distance of several miles with quite good results and at a reasonable cost. The water, with crude devices at first, was able merely to operate a few small flax mills here and there, but later, by ingenious mechanical improvements, the same streams were made to yield the power nec essary to drive large factories requiring many hundred horse power. Lately there seems to be a preference given to electrical transmis-



THE OLD MILLING DISTRICT AT NIAGARA FALLS.

sion. In no other place in the world, reasonably convenient to markets, does there exist such a power as is presented by the Falls of Niagara. The improvement by electrical transmission and transmission by compressed air points to the possibility of utilizing the power from the waterfalls over an extended area at a price that will compete with cheap coal as carried by rail. Very many years ago, Sir William Thomson, who acted as President of the International Niagara Commission, suggested that the time might come when New York and Philadelphia would be lighted by electricity generated from the Falls of Niagara. This prediction has not yet been realized, but improvements made in modes of transmission give promise of economical development of power certainly to the requirements of the great city of Buffalo.

One of the earliest proprietary maps issued showing the land on the American side of the Niagara River adjacent to the Falls of Niagara, owned at that time by Mr. Augustus Porter, claims to represent the country as it appeared in 1805, or when he came into possession of the property, having taken it up from the Government. In 1847 Mr. Porter issued a circular "to capitalists and manufacturers" with a view to the use of Niagara's water power. Paper mills and other factories already existed there. The efforts of Mr. Porter to rent power resulted in the completion of what is known as the Hydraulic Canal, which carries water to the mills on the bluff below Prospect Park. Mr. Porter's advertisement led to the location of a right of way 100 feet wide for a canal through the town of Niagara Falls to a forebay running parallel with the lower river and supplying mill sites. This canal was built beginning at Port Day. It varies in width from 25 to 35 feet and is not navigable. It thus occupies less than half of the width set apart for the purpose. The quantity of water that is delivered by this canal yields practically 6000 H. P., using say 47,000 cubic feet per minute, which power may be doubled by utilizing the whole of the available fall. Most of the manufacturers who put up buildings and took water from the canal were satisfied with a head of from 90 to 100 feet.

The execution of the present scheme, which originated with the late Mr. Evershed, Engineer of the State of New York, calls for a tunnel from property (about two miles of river front) owned by the company above Port Day, the tunnel being of sufficient capacity to carry off water required to develop about one hundred thousand horse power with a head of 140 feet. Mr. Evershed's

CREST OF THE HORSE-SHOE FALLS FROM THE CANADA SIDE.

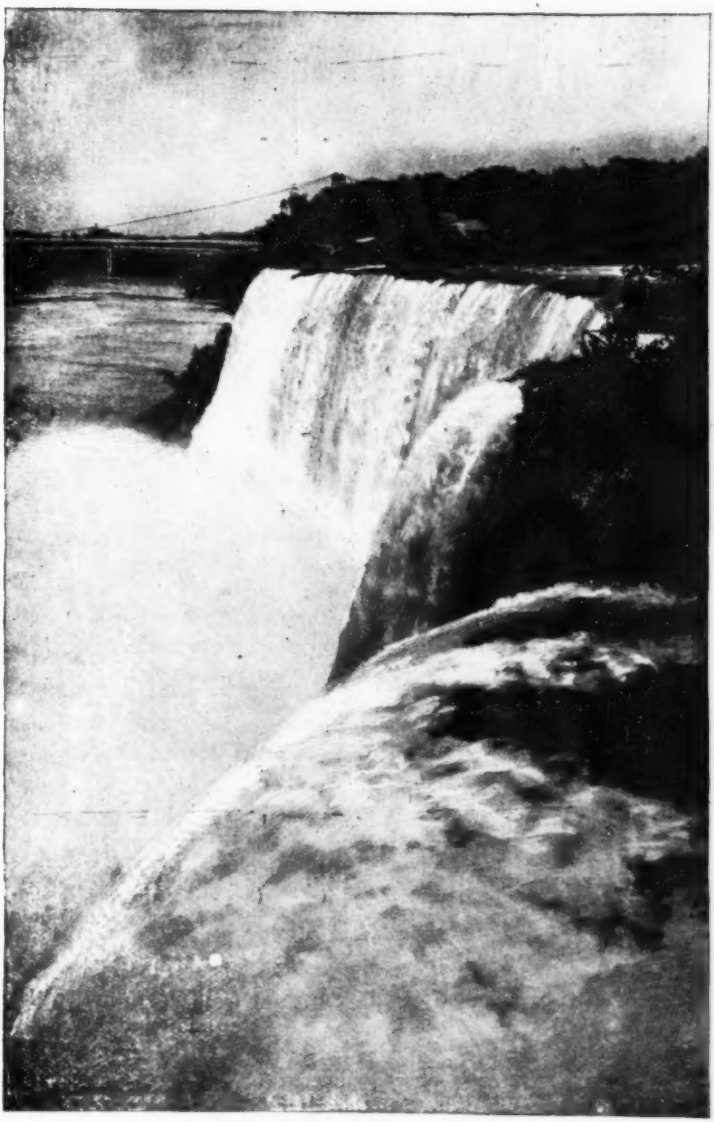
scheme contemplated a continuation of the tunnel parallel with the river on a moderate slope for a distance of about 13,000 feet from the mouth ; but with a length of 6700 feet a point is reached convenient as a manufacturing centre, where a central power station may be placed to yield power wholesale, to be transmitted by electricity or compressed air to the city at hand or more distant points. A navigable surface canal has been projected, that shall receive water from the river and be carried toward the west parallel with the railroad to a point where the first section of the tunnel will end. But of this canal it is the present intention of the company to construct only so much of the lower end, running inland northeast towards Buffalo Street, as will give a water supply capable of developing by a central power station the whole amount of power that the tunnel will yield.

The tunnel plan gives a larger acreage of mill sites than is possible by any other scheme, and in many ways is more economical. When we look at the Falls of Niagara in the light of a water power, the wide river above the Falls represents the mill dam and the gorge below the Falls the tail race. The tunnel being constructed is upon the shortest line that can be drawn from this pool above the rapids to the lower gorge, and even then is about a mile and a quarter long. By sinking shafts to serve as wheel pits upon

the property of the company, a fall of 140 feet can be made available, and the water that passes the wheels at this head will then be discharged into the tunnel and carried off and emptied into the lower river at a velocity ultimately of over 20 feet per second. To attempt to carry the same amount of water, yielding the same power at the discharging end of it, by a surface canal, would require a width of between 300 and 400 feet and a depth of from 10 to 15 feet; but such a scheme is inadmissible, as there is no property available for mill sites along the lower bluff, and public feeling opposes it.

The actual work that is now going on at Niagara consists in the driving of the tunnel, the completion of which is to render all after work possible. This tunnel finished and an entrance made from the river by the completion of some portion of the canal that is to feed the mill sites, power can at once be applied to a very considerable amount. The secondary transmission of power contemplates an extension, not only over the new town of Niagara Falls, but also to Tonawanda and Buffalo or elsewhere; the company having secured the rights to transmit power by any known methods. The several attempts that have been made in Europe to transmit power to manufactories from central stations, while in some cases yielding satisfactory returns, in others less profitable, have all demonstrated the convenience of power so transmitted to meet many wants. The readiness with which it can be applied, warranted a rate of rental that has in most cases been profitable to the producing company, even when steam generated by coal for fuel is the primary source of power, as is instanced in the cases of Paris, France, and Birmingham, England, where compressed air is the mode of transmission.

The water power of the Rhone at Geneva, Switzerland, where the volume of water is considerable but the fall only moderate, has been utilized by means of a pumping station from whence the water is raised to reservoirs on the hill and returned to the city by pipes under a much greater pressure, thus enabling a small volume of water to yield in small motors the power and speed required. Where electrical machinery is to be driven by water power and the head of water is not sufficient to give the power and velocity required, the speed must be obtained by gearing up, with attendant loss. In Geneva, small water motors made very sensitive by the regulating devices, are coupled directly to the shafts of the dynamos, and the speed of the wheel is adapted to the requirements of



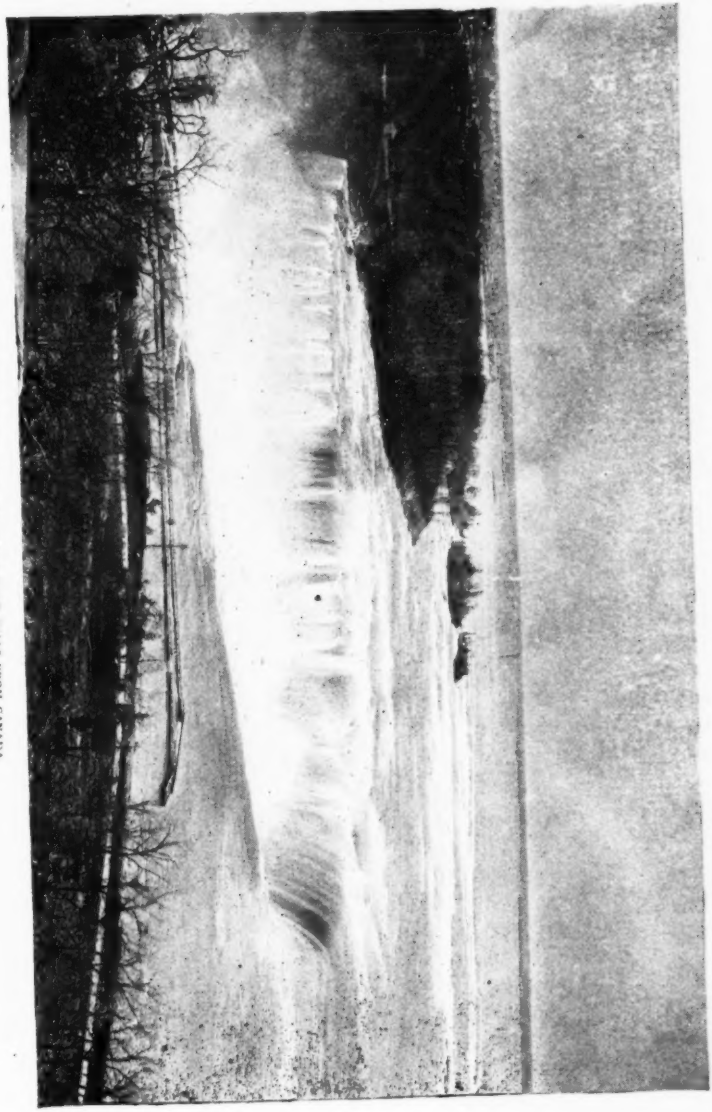
AMERICAN FALLS FROM GOAT ISLAND.

the dynamos. At Geneva we see the anomalous condition of the electrical station built on the rapidly flowing river, but not driven directly by the water that passes below the building, but secondarily by the water returned from the reservoirs outside of the city.

In our own country we find large industries scattered over extensive areas where electrical transmission in lieu of shafting has been adopted, even when the power required has to be converted into electricity and not used directly, solely on account of the convenience of the transmission and the facility with which the motive power can be carried to the machine to be driven. Roughly stated, power transmitted by line shafting in the usual manner a distance of say 380 feet, will lose in transmission to that distance fully 11%, while power may be transmitted the same distance by wire rope transmission with a loss of only 1½%, showing how much transmission has to do with the economical use of power.

Compressed air as a mode of transmission in Paris and Birmingham has been popular on account of the many uses to which it adapts itself. Existing steam-engines can be operated to great advantage, particularly when the air delivered from the mains is made to pass through a coil of pipes over a moderate fire and is so expanded and rendered more efficient, the heat so applied being fully five times more efficient than if applied to raising steam from water. For blast purposes the compressed air is used directly by causing a jet of the high pressure air to carry in a large volume of atmospheric air, when volume and not pressure is required, as in cupolas, blacksmiths' fires and in ventilation. Air driven motors are inexpensive and durable, and the air can be carried to the motor when it is not stationary by flexible tubing. Besides the cleanliness of the operation, the fact that the exhaust can be discharged directly into the rooms without detriment, makes it much preferable to steam. In a like way the recent development of the electric motor industries in this country has enabled electricity to be applied in many cases to the exclusion of line shafting for the transmission of power.

The work of the Niagara Power Company is now being carried out in such a manner as to permit the location of large or small industries in which each shall control his power and regulate it according to convenience by having the water-wheel under his own control. This is the ordinary manner with water companies, but with the exception of some of the large milling operations and wood



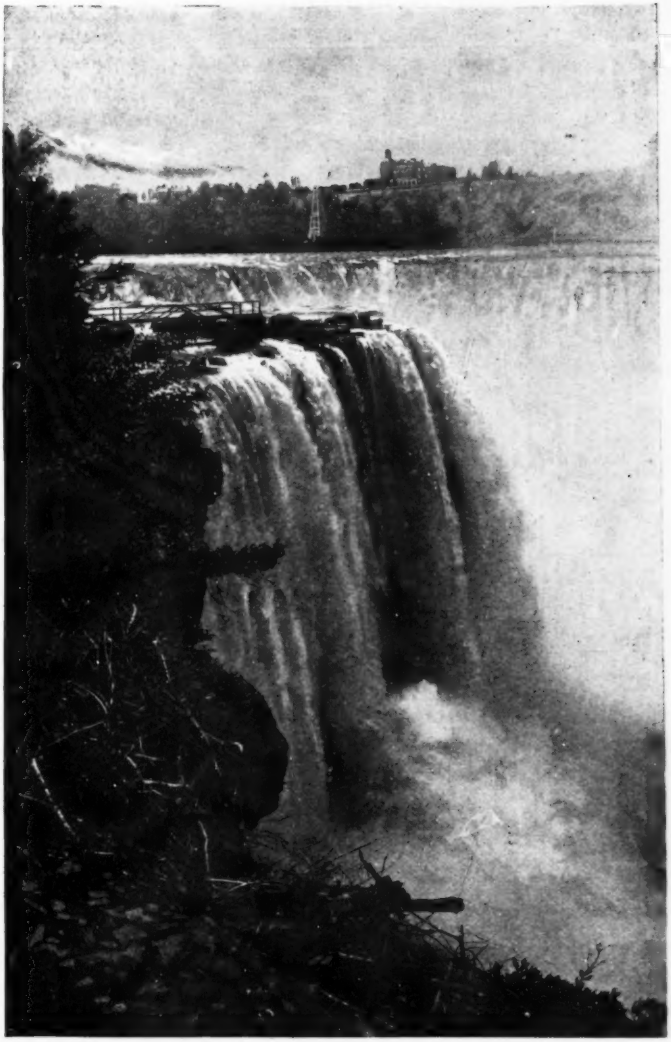
GOAT ISLAND AND THE HORSE-SHOE FALLS FROM CANADA.

paper pulp making, and in the metallurgical operations by means of electricity where large amounts of power are required to act upon a very few machines, there are very few manufacturing establishments that require, at least in the start, blocks of power exceeding 100 or 200 H. P., 1000 H. P. being sufficient to drive a factory for textile purposes of the largest size usually put into one building. It is the intention of this company to give this class of consumers what they want in the way of power, by means of a properly arranged central station. If the power by electricity or compressed air can be transmitted 20 miles at a loss of only 10% of its power, the force that this is capable of transmitting can be extended over a very much greater area than would be possible if each consumer of power controlled the force by using the water directly.

The work that is now rapidly progressing will result in a tunnel of a horse-shoe form, securely timbered until ready for the brickwork, and then lined throughout in a very substantial manner, provided such lining is found necessary, through the entire length of the tunnel. Two shafts have been sunk, while the entrance from the river permits another gang to discharge the contents of the tunnel from the heading directly into the river, and to thus permit five breasts to be driven at the same time. The power used to effect this work is compressed air, a very large plant having been erected for the work.

The country is seemingly level, but a contour map of the land shows it to afford ample facilities for drainage. The tunnel that is now being built will furnish ample discharge for power to the extent of 100,000 H. P.; but in addition to this, in view of future possibilities, a right of way has been secured for a second tunnel under the town to discharge lower down the river. Upon the completion of the tunnel and erection of a central station, compressed air will be given to the existing factories to take the place of steam, at a lower rate per H. P. than will be possible by fuel, and the boilers can then be used for other purposes where steam is used for heating, or electric motors can be substituted for the engine and boiler.

Most water powers, variable in quantity between high and low water, can be portioned out equally for use all the year round, only so far as their minimum total power goes. At times there may be much water to spare, but this excess of power is variable in duration. All ordinary water powers, however, are in jeopardy from excessive drought or excessive floods, for at times the torrent may



HORSE-SHOE FALLS FROM GOAT ISLAND.

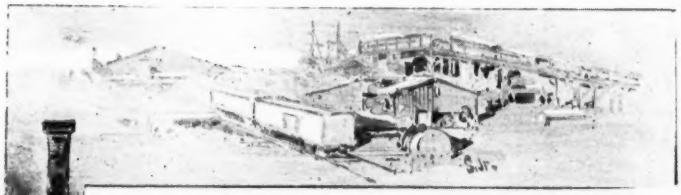
overflow the banks and obliterate all the difference of level that is the source of power. All artificial water powers are liable to the danger of the giving way of the dams erected at great cost. In spite of all these objections, streams yielding power have been the means of building up great industrial centres, where finally steam power exceeds the original water power that was the first attraction. Niagara alone, the great wonder of North America, is capable of yielding a never-varying power, capable of supplying all the demands of many Lowells and many Holyokes. It alone of all water powers is capable of being made to yield its force in large or small quantities according to man's need. This requires that its power shall be controlled and rendered capable of transmission to the doors of the working people, just as the water they drink and the gas they burn is now delivered to them. Few industries use power in a crude form applied directly to the work, as is the case in the ocean steamer with its engine of 14,000 H. P. merely turning the blades of the propeller. In most cases on land the power must be changed to suit the work to be done, and it is in the changing back and forth from this form of motive force or mode of transmission to others that the loss occurs. The time is now coming when water wheels of great power at Niagara will be made to transmit through a single shaft, as from the engine of the steamship to the propeller, the whole power to a single dynamo or air compressor above ground, which can deliver a cheaper and more convenient power to the consumer than a manufacturer can obtain by means of a single water wheel of his own, unless he be close to the source of power. Beyond this close proximity, the localities served will be made alike by cheap transmission, and this widespread service is what is contemplated by the organizers of this mighty enterprise. Manufacturers are ready to take power from outside when it can be delivered to them on reasonable terms. Such industries as the Baldwin Locomotive Works in Philadelphia, covering many city blocks, generate their own electricity and it is doing the work more conveniently and more economically than the same power transmitted by shafting, only because they can make that electricity cheaper than the companies organized for lighting are willing to furnish it. Many manufacturing establishments are considering the concentration of their generating power with electrical transmission and fully appreciate the advantages of a cheap power transmitted to them in such a way as would free them from the cost and inconvenience of their present steam system and give them additional space.

The plans of the Cataract Construction Co., are in the direct line of modern advanced thought. This great work will in 1893 incline the people of the world who will be attracted to Chicago to consider the work now being done at Niagara Falls as part of America's progress. Stranger things have happened than that Niagara Falls itself should exhibit its power in transmitted force carried by wire to the international Columbian Exposition.

AMERICAN AND HORSE-SHOE FALLS FROM BELOW.

TUNNELS AND MODERN METHODS OF TUNNELLING.

By E. W. Moir, Assoc. M. I. C. E.

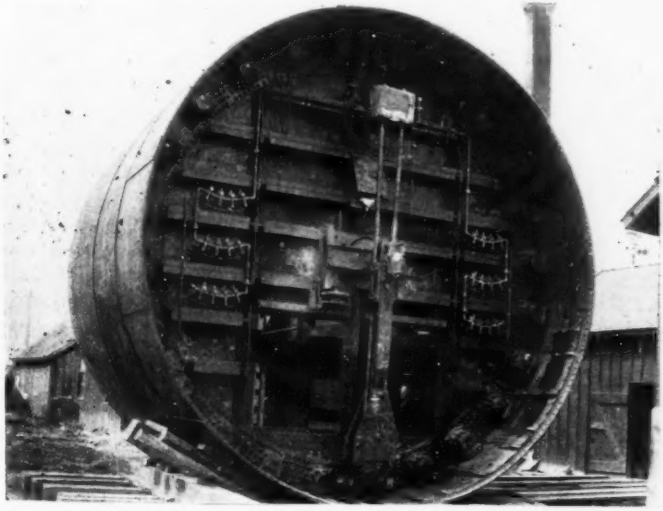


IN the development of its great railroad system, America has not had the same necessity for tunnels as the older European countries, where the cities as they stood required to be connected, and the crooked and narrow streets would not allow of crossings at grade; whereas in America, in many cases the cities have been created by the construction of the railroads, which have been pushed out across the plains on lines causing the least amount of expenditure.

The future is to be an era of tunnelling operations. The conditions of our modern civilization demand dense populations in restricted areas; and at the same time we must be able to get rapid passage through our great bee-hives of industry. The surface is required for local movements,—the air as yet has not proved itself amenable to navigation,—and there remains but one other unutilized part of the universe, that being the earth below its surface. Tunnelling is the only means of making suitable channels of traffic, and all the large cities of the Old World have their underground arteries. Again, with the growth of inland navigation, bridges, unless at very high levels, will not be allowed; while the low level of the banks of many rivers will not permit of the rails being raised sufficiently to allow of a passage for even small craft, and the clumsy device of a swing or draw bridge, with its attendant delays and dangers, has to be relied on.

So far bridges have been used in America for the crossing of the mighty rivers, and as yet there is but one completed

subaqueous railway tunnel on the continent; whereas in England alone there are under large bodies of water the following: the Severn Tunnel, 22,992 feet long; Brunel's Thames Tunnel, the first to be built with a movable shield, 11,880 feet long; the Tower Subway; and the two Greathead tunnels, on the recently completed and much talked of electric rapid transit system, all of which also pass under the Thames. At Liverpool there is the Mersey Tunnel 23,760 feet long, and at present one going on under the Clyde at Glasgow.



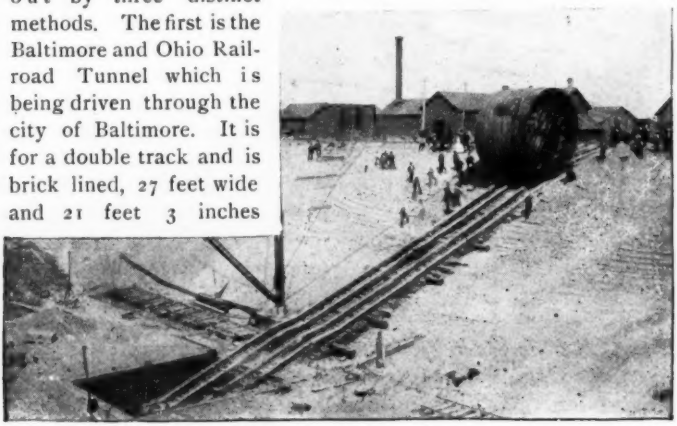
THE ST. CLAIR TUNNEL—REAR VIEW OF SHIELD.

Of tunnels above water level the most noteworthy are: the St. Gothard, 48,840 feet long; the Mt. Cenis, 39,840 feet; the Hoosac, 25,080 feet; and the spiral tunnels in the Alps, on the St. Gothard Railway, which were built with the object of increasing the distance down the mountain, so that suitable grades could be made. There are two tunnels, almost complete circles, through the rock, the train emerging near the same spot at which it entered, though lower down the slope. Now in New York, as in the European cities, the necessity for tunnels has arisen, and the public press is full of tunnelling schemes, intended to facilitate the move-

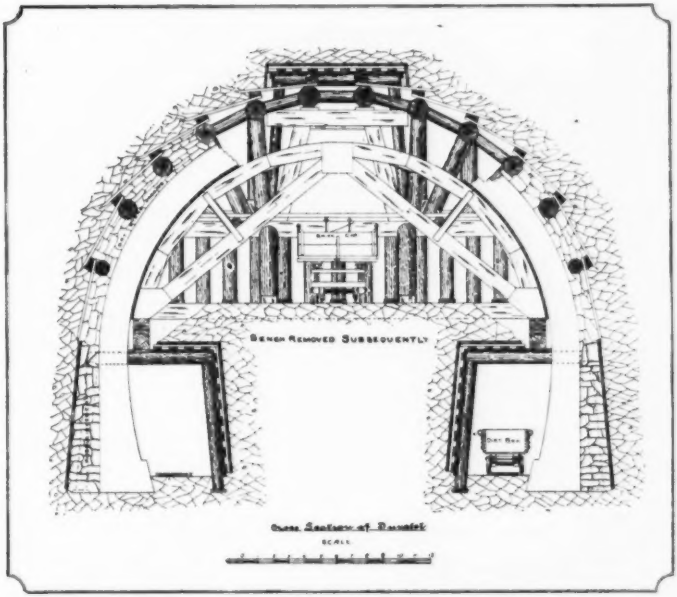
ment of the masses of people who daily work in the city and sleep elsewhere. There is the proposed Forty-Second Street Tunnel, connecting Long Island City and Manhattan Island, the Battery and Brooklyn Tunnel, the Narrows Tunnel, the Rapid Transit Scheme; and lastly, the Hudson Tunnel, of which there is now completed 4000 out of 5489 feet, which is to form a connection between the railroads from the west, terminating in Jersey City, and New York.

A tunnel becomes a necessity or an advantage under the following conditions: where a rise in the earth's surface is steeper than 2 in 100, the level of the rails being such that the surface will be more than 80 feet above them for any distance (always assuming it is more economical to tunnel than to go the greater mileage round the obstruction)—or where in cities property is too valuable to allow of a railroad on or above the surface. It is also often necessary in the case of a large sewerage system, or water supply. New York has in its vicinity a noble example of the latter in the Croton Aqueduct, and in Brooklyn there is now under construction one of the largest sewer tunnels ever built, the novelties of which will be touched upon later. The nature of the material to be tunnelled through determines the design and method of construction, and its qualities are ascertained by borings or trial pits.

There are in this country at present three examples of the most difficult classes of tunnelling operations, which are being carried out by three distinct methods. The first is the Baltimore and Ohio Railroad Tunnel which is being driven through the city of Baltimore. It is for a double track and is brick lined, 27 feet wide and 21 feet 3 inches



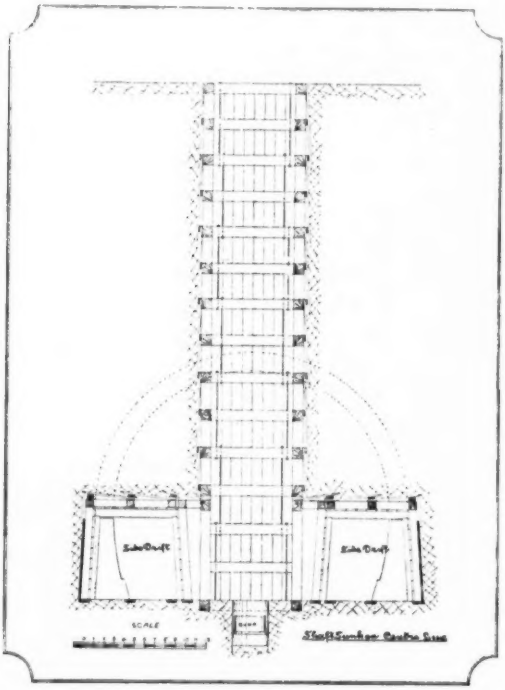
THE ST. CLAIR TUNNEL—ROLLING A SHIELD INTO PLACE.



BALTIMORE TUNNEL—TIMBERED CLASS, SHOWING BRICKWORK NEARLY COMPLETE.

high, the brickwork being 1 foot 10 inches thick. The material is very wet, and is composed of clays, coarse gravel and sand, requiring careful mining to prevent settlement of the foundations of the buildings along the streets through which it passes. This tunnel is an example of the timbered class, the ground being excavated and supported by oak struts and beams until the brick work can be put in. The amount of time allowed for completion determines the number of points at which the tunnel must be worked, and fixes the number of shafts to be sunk. These, by preference, should be directly over the tunnel, rectangular, and wide enough to allow the side walls to be built at the bottom without further excavation. At Baltimore this is impossible in all cases, as the tunnel runs under Eutaw Street; so buildings were acquired at the side where the shafts were sunk, and cross drifts, or small temporary tunnels, driven to the further side of the tunnel proper.

The shafts are excavated a few feet down at a time, the sides being planked and strutted to prevent the falling of the material



BALTIMORE TUNNEL—A TIMBERED SHAFT.

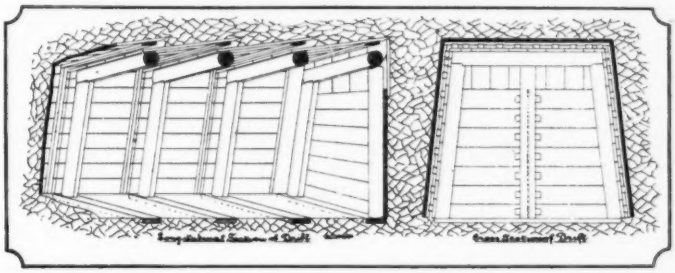
without, each shaft being provided with the necessary hoisting machinery for taking out the excavation and lowering the materials used in the construction. From the shafts or drifts so completed, headings are driven in various parts of the proposed cross section of the tunnel. Mr. E. J. Farrell has introduced in Baltimore the plan of cutting out two headings, one at each side in the bottom, in advance of the main excavation, in which he builds the side walls ready to support the arched roof. By this means the gravel is drained of its water before the greatest amount of work is done, and the whole excavation is not exposed for so long a time without the brickwork supporting it, as it would be if the side walls had to be built.

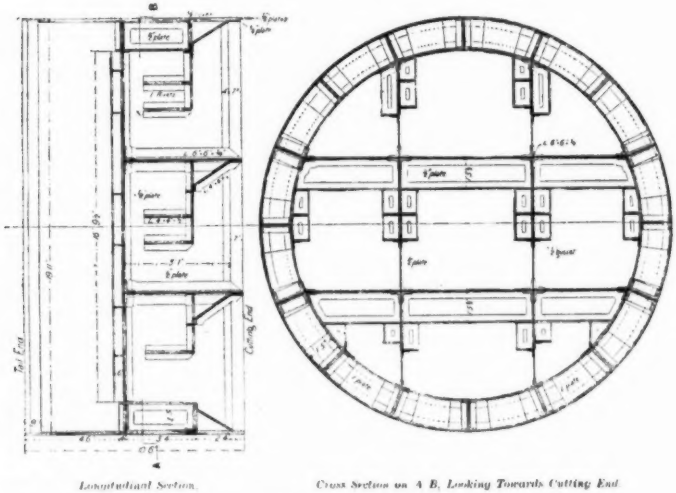
The second example mentioned above is Messrs. Anderson & Barr's system of tunnelling, which is now being carried out on the 15 feet sewer tunnel in Brooklyn. It is well adapted for the fine dry sand through which the work passes. It was invented by Mr. J. Anderson, and first used by him in the Hudson Tunnel, the construction of which was thereby made possible. In this work, however, as the deeper water and softer silt was approached it was thought advisable to adopt another method.

The Anderson system consists essentially of the use of a central iron cylinder, called a pilot tube, which is built in advance of the full size tunnel and serves as a solid structure, supported, as it is, at the one end in the finished brickwork and at the other 15 or 20 feet in the undisturbed material. The pilot is about 6 feet in diameter, made of interchangeable plates bolted together, which are taken off the back as the work proceeds, and fastened on to the front. Timber struts, about 5 or 6 inches in diameter, radiate from it like the spokes of a wheel from its hub. They support thin steel plates, which are joined together by bolts, and thus form a shell to hold up the undisturbed material outside the line of excavation. This shell is composed of plates $\frac{1}{4}$ of an inch or less in thickness, according to the nature of the soil, and from 12 to 24 inches wide, the wider ones being used upon the sides where there is less direct weight. The extent to which the plates are carried down the sides is also dependent on the adhesiveness of the soil, and $1\frac{1}{2}$ inch planks are often substituted for the more expensive steel plates, if the soil is suitable.

One great point about this system is that there is no space left for after settlement as there is between the timbers of the old method of tunnelling, and less material is taken out, because in the timber method about 2 feet to 2 feet 3 inches is required all round the outside of the brickwork, to allow the timber to be placed. The face of the material to be moved is always planked or polled in running wet or dry sand, the great object being to prevent movement, as it is hard to stop when it once commences.

The method of tunnelling which has attracted the greatest amount of notice lately is the so-called Greathead system, which though not wholly new, some of its principles having been used first in 1868 in the Tower Subway in London, is the one which will play





Longitudinal Section. *Cross Section on A B, Looking Towards Cutting End.*

HUDSON TUNNEL—SHIELD.

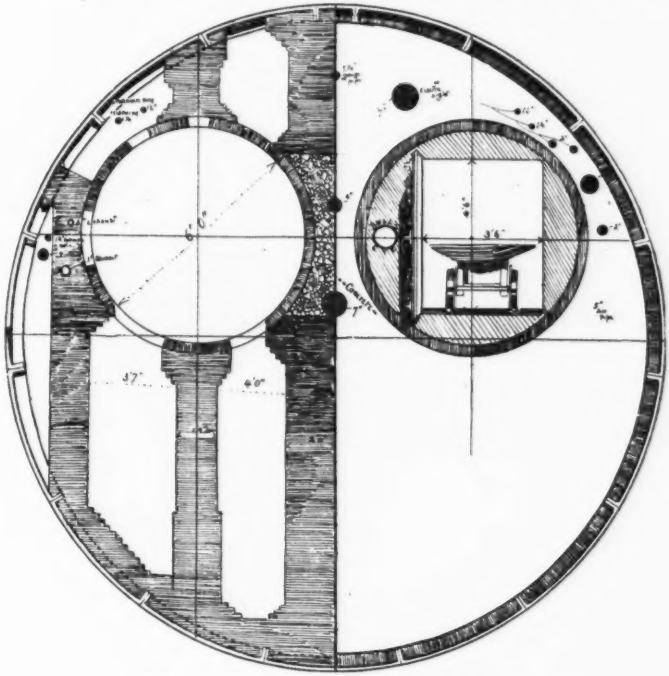
the most prominent part in the tunnelling operations in the future in soft ground. In this system a shield is pushed in advance of the completed work, the back part overlapping the tunnel already built, as does the cap in a telescope. It is provided with doors through which the excavated material is removed, and is pushed forward by hydraulic jacks. The tunnel is circular in form, and is composed of cast-iron segments, varying in thickness according to its size and the weight of the material above it. The segments are bolted together and to the last completed ring, each one adding 1 foot 6 to 1 foot 8 inches to the completed length.

Mr. J. H. Greathead was the engineer of the new underground road that was opened in London a few months ago, which has been so successful and popular. The tunnels are deep down in the London clay, 60 or 70 feet below the surface, away from all possible disturbance of the foundations of buildings, the passengers being raised and lowered by elevators at each depot, large enough to take 50 people at a time. One tunnel is provided for each direction, and the motive power used is electricity, from which arises no smoke or gas. As one tunnel is provided for each track, trains carry sufficient air with them to keep the tunnels fresh. Under the Thames the two tunnels, which start side by side, turn

one over the other, in order to pass along a narrow street leading down to the river.

There is absolutely no surface settlement in this method of tunnelling, as it is prevented by the pumping of cement grout in the space which is left between the lining and the sides of the cavity formed by the advancing shield. This also forms a casing which prevent the corrosion of the iron. It was by this method that the St. Clair Tunnel, connecting Canada and the United States, was driven under the St. Clair River at Port Huron. It is 21 feet in diameter outside, composed of cast-iron segments. It was built at an average speed throughout of about 7 feet per day, from each end, and was driven through clay mixed with occasional boulders.

The Hudson Tunnel is also being driven by this method by the



Half cross section. Half end elevation.

HUDSON TUNNEL—AIR LOCKS AND BRICK DIAPHRAGM FOR RETAINING COMPRESSED AIR—CAST IRON LINING.

contractors, Messrs. S. Pearson & Son, of London. The material is so soft that when the shield is being pushed, it comes through the doors like the meat from a sausage machine, travelling by reason of the smallness of the openings ten times as fast as does the shield itself, which moves at the rate of 2 inches per minute, which in ten minutes gives the necessary distance for a ring of plates.

A complete ring of segments weighs 14,000 lbs., and is composed of 11 large plates, and a key-piece 12 inches wide. The larger pieces weigh 1200 lbs. each, and require to erect them some special appliance. Hydraulic power is the most suitable for such a purpose, and the illustration shows an ingenious contrivance de-

HUDSON TUNNEL—AIR LOCK DOOR.

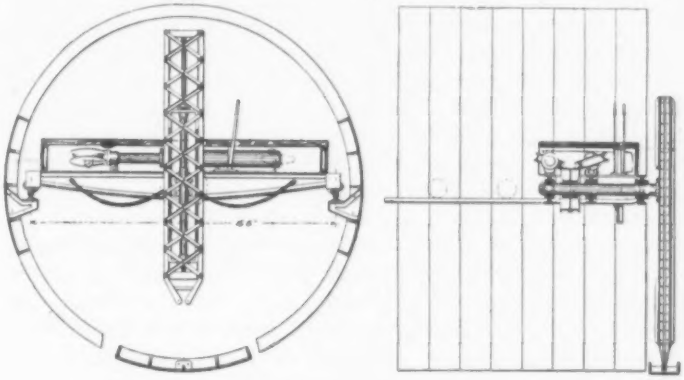
From a photograph taken in a pressure of three atmospheres.

signed for the work. It consists of an iron frame-work or carriage supported on wheels, which run on rails attached to the lining on each side. A shaft in the centre of the frame-work and of the tunnel, is made to revolve by two hydraulic cylinders, having fixed to its end a lattice girder arm, which is telescopic. The cast-iron segments are attached to the end of the arm in the bottom of the tunnel, and it is then drawn in by hydraulic rams contained within

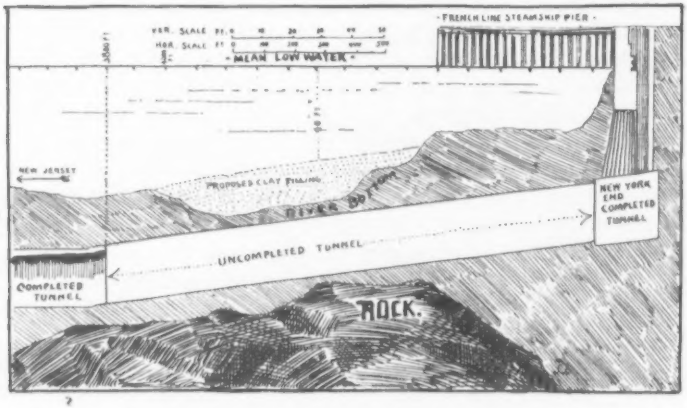
it. The central shaft is now revolved into the desired radial position, and the plate pushed back against the inside of the tail end of the shield,—when it is bolted to the other plates. With this arrangement a complete ring can be easily erected in from 45 minutes to 1 hour. One man, with two levers, controls all the movements. When the ring is complete, one of the supporting brackets on which the rails rest, is taken from behind and passed to the front, and the whole frame travelled forward by a 5″ hydraulic jack with its axis along the tunnel.

The high pressure pump which supplies water at 3400 lbs. per sq. inch to drive the shield, also supplies the necessary water at 1000 lbs. per sq. inch to work this hydraulic erector. Owing to the soft nature of the Hudson River mud, compressed air has to be maintained in the tunnel, as was also done in the subaqueous portion of the St. Clair Tunnel.

The air is supplied at 31 lbs. per square inch, and is retained at the face by passing it through a pipe built into the brick diaphragm, or wall across the tunnel, in which an iron shell or air lock, 6 feet in diameter by 16 feet long, is fixed. This air lock has a rubber faced door at each end, both opening towards the greater pressure. One is always closed, and the pressure can be raised in the space between them to the higher amount at the face, or reduced to the lower atmospheric pressure, by suitable valves controlled by the man attending the lock. The working is precisely



THE HYDRAULIC ERECTOR USED IN PLACING THE PLATES.



HUDSON TUNNEL—LONGITUDINAL SECTION SHOWING PROPOSED TEMPORARY FILLING IN RIVER BED.

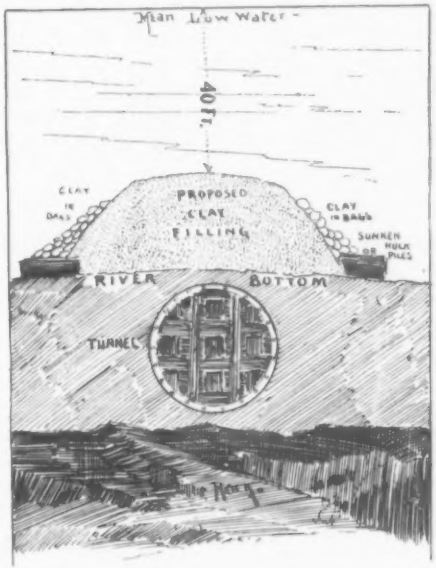
similar to that of a canal lock with a cover over it, and air at different levels of pressure taking the place of the water.

On entering the high pressure air chamber an unpleasantness, often amounting to acute pain, is felt in the ears owing to the fact that there is a small passage from the throat to the back of the drum of the ear, which opens only in swallowing, and this should always be done when entering high air pressure. Care should also be taken on coming out of high pressure air, and the men employed should be examined by a doctor before starting on such work.

The terminal facilities of the Hudson tunnel have been made a special study by W. Buckholz, chief engineer of the N. Y., L. E. & Western, who is a specialist at this class of work. A large union depot will accommodate all the railway companies which now have their termini in Jersey City, and a fine hotel, having 600 rooms, has been designed by a leading firm of architects in the city. The concession lately granted to the contractors by the United States Government to dump 15,000 yards of clay will enable the tunnel, which is rapidly approaching the deepest portion of the channel, to be arranged with grades of 2 feet in 100, an arrangment that would not have been possible if this permission had been refused. The line can now also be carried over the top of a bench of rock about 1200 feet from the New York bulkhead, the cutting through of which, with the small amount of soft silt over it, would have been a very slow and tedious operation, as land

water would probably have been found in the sand just overlying this rock.

The ventilation of tunnels is a serious problem, and indeed an insurmountable difficulty if steam and smoke are allowed to issue from trains passing every few minutes in different directions in the same tunnel. If each track has a tunnel to itself the passing of the trains through it will cause a certain amount of circulation, quite sufficient (if any other power than steam is used) to keep the atmosphere pure enough to breathe. For safety an absolute block system should be provided, whereby no train should be allowed to enter a section until the previous one has passed the next signalling point; and where there is great traffic, and consequent smoke or steam, explosive torpedoes should be placed upon the track, either by a mechanical device connected with the signal station or by hand.



HUDSON TUNNEL—CROSS SECTION SHOWING PROPOSED CLAY FILLING IN RIVER BED.

The cost of tunnelling operations varies enormously, according to the nature of the material. Brunel's first Thames Tunnel cost $5685 per yard of length. The recently completed Sarnia tunnel cost about, for a single track, $900 per yard or $1800 per yard for the two tracks, for ordinary sized rolling stock. The contract price for two Greathead tunnels under the Thames was $210 for two tracks.

Ordinary double track tunnels through cities in the United States should not cost more than $600 per yard, unless exceptionally heavy buildings have to be passed under or other obstructions have to be overcome. In open country a similar tunnel, in good

ground, could be built, if timber is not very dear, for $425 to $475 per yard. The Mt. Cenis tunnel cost $835 per yard, and the St. Gothard about $600. Two small tunnels suitable for a rapid transit scheme for New York City could be driven, and made ready for the track, at $1,000,000 per mile (exclusive of property for the stations) and without any risk to the foundations of the buildings or disturbance of the surface of the street.

We have not mentioned, owing to want of space, the process of tunnelling through rock, which is the simplest of all such operations. Examples of such works are to be seen in the tunnels through the Bergen Hill on the Erie and Lackawanna Railroads. For similar reasons we have omitted the "cut and cover" examples, among which would be included the underground railways of London and Glasgow, the tunnelled portion of the New York Central & Hudson River Railroad, and the Pennsylvania Railroad Tunnel in Baltimore built in 1871 to 1873.

THE DISPOSAL OF SEWAGE IN ENGLAND.

By T. Kennard Thomson, Assoc. Mem. Am. Soc. C. E.

THE ancients thoroughly understood the necessity for keeping their dwellings and persons clean, and realized that pure air, pure water and good food were essential to good health. Alexandria, Rome, Carthage, Jerusalem, and many other cities had complete water and sewage works, many of which were on a gigantic scale, as the Cloaca of Rome which has been in use for twenty-five hundred years. The ancient Egyptians worshipped the Scarabæus or scavenger beetle (our "tumble" bug); the Hebrews buried their excretions at some distance from their dwellings, and the Greeks and Persians had very enlightened views on the subject of sanitation. In Jerusalem the sewage was collected in tanks and allowed to settle, when the liquid was drawn off for irrigation purposes and the solids were used for manure. We can only improve on this in purifying the liquid by precipitation.

But in the Middle Ages Europe sank back in the scale of civilization, and for nearly 1000 years scarcely a man, woman or child paid attention to personal cleanliness. The moats and cellars of the old feudal castles were filled with filth, and often contained a dozen or more abandoned cesspools which were merely covered with a thin veneer of earth. In fact, it was not until the death of Prince Albert that Queen Victoria had these poison generators removed from Windsor Castle. Is it then surprising that cholera, "The Black Death," insanity and other plagues found so many easy victims?

Twenty-two years of war cost England 80,000 soldiers, while 145,000 people lost their lives on the little island in a single year from cholera, which was due to the unsanitary condition of the country. The death rate of London has been reduced from 80 to 21 per 1000 in the last two hundred years owing to the sanitary reforms.

A commission appointed to investigate the sewage of Paris some years ago had a sample of sewer gas taken from the Seine and analyzed with the following result:

Carbonic acid gas	72.88	per cent.
Carbonic acid	12.30	"
Carbonic oxide	2.54	"
Hydrosulphuric acid	6.70	"
Sundries	5.58	"
	100.00	"

Small animals placed in a vessel holding this gas were at once killed. A book might be filled with instances which prove that scarlet fever, typhoid, cholera and other contagious diseases are spread by means of the disease germs in the dejecta of a patient. If the germs are deposited in a cesspool they will probably find their way to the nearest well; if into a sewer, they are propagated and rapidly carried by the sewer gas to different houses. A few notable examples will here suffice. In 1847 typhoid fever broke out almost simultaneously in thirteen houses in Clifton, England, all of which used the same well, while the houses scattered among these thirteen, but which obtained their water supply from other sources, had not a single case. In 1866 some infected sewage was pumped and then discharged down an open channel about ninety feet long through a clean, healthy district in Southampton. A few days after this stream had received the dejecta of a cholera patient, a violent epidemic of Asiatic cholera broke out, in spite of which the open sewage waterway was left for a fortnight. During this time one hundred and seven people died; but as soon as the channel was closed the epidemic ceased. Kentish-Town, a suburb of London, had an attack of scarlet fever in a whole row of detached houses. These had no communication whatever except through the sewers, all of which drained into a cesspool which was unventilated except through the houses.

In country houses and small towns, the safest way to dispose of the excreta is to have a galvanized iron pail directly under the seat, keeping the objectionable matter covered with house ashes, to which a slight addition of new slacked lime would be very desirable. The contents of the pail can then be safely used for manure. Kitchen slops can be used to water the garden, but care must be taken not to empty them so often in the same place as to clog the soil. Fresh soil is the best purifier for animal refuse, as it contains more condensed oxygen than even the atmosphere, and transforms the objectionable animal matter into food for plants.

The dry earth or ash system would also be the best for large

cities, *if* people could be educated to use and not abuse it; but as they cannot, we are obliged to use the water carriage system. When first water-closets were adopted, they were drained into a covered cistern or cesspool, which had no exit for the gases from decomposing matter except through the dwellings. Can anything worse be imagined? Yet there are hundreds of people in this country and abroad, who will allow this to go on for years and still wonder why their families are so troubled with general debility if not killed outright. To show how difficult it is to prevent cesspools from contaminating a well, if the soil is at all porous, the case of a man in Kentucky may be cited. He sank a well below the bed of a mountain river to a very porous strata containing water, and while he was working he rendered the water in his own well muddy, and also that in his neighbor's on the *other side* of the river. When he stopped work, the water again became clear in both wells.

In modern cities sewers are the most effective vehicles we have for propagating contagious diseases, and sewer-traps are largely to blame for this, as they give a false sense of security. The only effectual means of preventing the passage of sewer gas through a trap, is to make it easier for it to go somewhere else by placing a large, perfectly straight ventilation shaft just below every trap. The traps should also be made of glass, and always capable of easy inspection. As a rule a man will be willing to pay thousands of dollars for decorations, and yet begrudge every cent he puts into plumbing. In this he is often unrestrained by a large class of architects.

After having adopted the water carriage system, and seen that the sewers are properly ventilated and free from leaks, the next consideration is the disposal of the sewage.

The old practice of polluting rivers and lakes is being done away with in England much more rapidly than in this country, and it is now universally conceded that if the sewage is to be emptied into rivers and lakes or even into the ocean it should be first purified. The oldest system of accomplishing this purification, that of downward filtration, has been proved over and over again to be a failure, being too expensive in requiring too great an area of land for effectiveness.

Sewage farms, although still advocated by some, are being generally condemned. The writer carefully inspected several which are considered especially good, notably those at Southampton, Ealing and Croydon, and found that one and all gave off such of-

fensive odors that they should not be tolerated. The government will not allow the best sewage farm within one hundred feet of a public road. The advocates still argue that the land is greatly improved by the application of a sewage effluent, but experience proves the reverse. The tendency of everything grown on these farms is to go to leaf instead of fruit ; in fact the only crop that really flourishes is that of rye grass. It has been proved that cows fed on these farms give inferior milk to those fed on ordinary grass. Two fields exactly alike were taken, and one watered with sewage effluent. A cow was then pastured in each field, and it was found that the milk, cream, and butter of the cow in the unwatered field were far superior to those of the cow in the watered field. Then, as a check, the cows changed pastures, and after a while their products were again tested, and still found better from the field which had received no sewage.

In London they tried a very bold scheme which naturally failed. The sewage was collected in reservoirs below the city, where it was loaded on barges and carried off to be dumped into the German Ocean. Is it hard to understand why the people along the banks of the Thames made it troublesome for the city authorities ?

The scheme of decomposition by electricity has not yet merged beyond the experimental stages. The great objection to this system is that it will always be very expensive, as it is all outlay and no income and thus an absolute waste.

Finally comes the system of precipitation, which in the opinion of the writer is the one of the future. The only question is, has the proper precipitant yet been discovered, and if so, what is it ? As the English have tried nearly every conceivable substance we can well profit by their experience ; so I will give here a list of a few of the substances which they have put to practical tests and the results thereof :

Gypsum (sulphate of lime). When organic matter undergoes decomposition in the presence of such sulphates as gypsum, sulphuretted hydrogen is given off in abundance. There is a case on record where gypsum was added to sewage to aid in solidifying it, and sulphuretted hydrogen was given off to such an extent that the workmen suffered temporary blindness.

Lime, one of the most common precipitants, yields an alkaline effluent, which at once excludes it, because putrefaction becomes more active in alkaline solutions than in such solutions as are neutral or acid. Alkalinity is a condition insisted upon in all experi-

ments on the culture of the microscopic organisms, and in all attempts to generate life from dead matter. Moreover, a lime effluent is well known to be deadly to fish; and again, when tanneries and dye-works discharge into the sewers the lime is liable to "fix" their colors, so that it is impossible to render the effluent colorless. Lime has been extensively applied at Tottenham, Blackburn and Leicester for the production of manure, and in each case turned out a conspicuous failure.

No soluble sulphide should ever be allowed to enter a river. Hypochlorites, such as bleaching lime and the corresponding magnesia and soda, must also be excluded.

Salts of Barium while they remove any sulphuric acid, free or combined, and will also precipitate carbonic and phosphoric acid, are extremely poisonous. Free acids, common salts, petroleum, coal tar, etc., have been tried and abandoned. Alum is too expensive, and besides it contains a large proportion of an alkaline sulphate. Aluminium acetate is prohibited by its cost. Aluminium salts have not only the property of precipitating the dead matter but can also to a great extent destroy disease germs. Carbonates of any kind, or any substance which continues to give off gas after being mixed with sewage, are to be condemned, as the bubbles disturb the sediment.

Salts of Manganese are excellent precipitants, for besides carrying down certain impurities, dissolved as well as suspended, they destroy other impurities by transferring to them a continual supply of oxygen from the atmosphere. This property is more or less marked in the salts of all metals which have two grades of oxidation; for any salt of the higher oxide in contact with organic matter is reduced to a lower oxide, and the hydrogen which is given off burns up (oxidizes) the organic impurities, whether dissolved or suspended. The lower oxide then takes more oxygen from the air, and the former process is repeated over and over again. Sulphate of Manganese is too expensive. The objections to zinc, copper, burnt clay and ground clinkers are too obvious to note. Coke is a good purifier but does not improve the manurial value of the sludge. Charcoal if used must be thoroughly well burnt, otherwise it retains the fatty and tarry matters which repel the water and prevents it from penetrating the pores. Cement—Portland or Roman—has been repeatedly proposed but has nothing to recommend it.

The Amines process—that of arresting putrefaction and destroy-

ing bacteria by chemical means—is still in its infancy and untried.

The two principal towns in England in which the Porous Carbon System has been adopted are Coventry and Southampton. Mr. Coddington, the engineer of the Coventry Works, very kindly showed the writer over his system.

These works are about a mile from the picturesque old town of Coventry. The sewage flows into an open drain in which a large wheel, about twelve feet in diameter, revolves. This wheel has a broad band or tire around it, about eighteen inches wide, and has one side covered with a wire screen. As it revolves all the solid fæces, etc., are caught up by the tire and spokes and thrown to one side, and are then taken off in wheelbarrows to another part of the yard. The smell thrown off can be easily imagined.

The remaining sewage then flows into a tank where it is mixed with porous carbon by a kind of churn; thence it flows into a smaller tank where it is mixed with lime,—the error of which has been already pointed out. The fluid is then allowed to flow into a large open cistern where it is left to settle for a few hours, after which the effluent is drained off into a ditch and allowed to find its way to a neighboring river, and the remaining sludge is then shovelled into a heap in the yard to dry. Some of it is thus sold to farmers for manure at from fifty cents to seventy-five cents per small load, while the rest is pressed into cakes by machinery and then sold. The fæces which were thrown into the yard in the first place are either mixed with sludge or sold for manure pure and simple. It is needless to say that we are not liable to copy much from Coventry.

Coventry shows the Porous Carbon System misused and mixed up with other substances, while Southampton on the other hand, after having used the Porous Carbon System in one-quarter of the town so effectively and economically for four years, determined to treat the sewage of the entire town by this process. Up to 1885 a small portion of the sewage had been taken up by a sewage farm, while the balance was turned into the tideway, where it killed off the fish and caused such an unpleasant odor that the Royal Yacht Squadron threatened to remove their headquarters from Southampton unless something was done at once. So the board instructed Mr. W. B. G. Bennett, its Borough Engineer, to see what he could do. He built two large tanks or reservoirs under the docks, as land was hard to get, and about a hundred yards from these tanks he placed a perforated box in the sewer, which he

kept filled with porous carbon. Over this he placed a vessel of water with a tap to regulate the supply, by which means he could dilute his carbon at pleasure. Now, as all sewage had to pass through this box of porous carbon, by the time the mixture fell into one of the reservoirs it was pretty well stirred up, and was then left to settle for a few hours while the supply was diverted to the other reservoir; and before this was filled, the porous carbon had precipitated all the solid part of the sewage to the bottom, leaving comparatively pure water on the top which was drained off into the bay. The sludge was then transmitted by pneumatic force through a four-inch cast iron pipe to another wharf nearly a mile away (being the nearest available land), and discharged into a cell, whence it was drawn as required and mixed with road-seepings or sorted house refuse; and being then a good, dry, portable manure, was bought up by farmers as soon as ready, for about forty cents a load at the works. The sewage is thus separated, the harmless portion turned into the bay, and the remainder turned mto valuable manure, which more than pays for the works. The fish returned, the odors disappeared, and the Royal Yacht Squadron was satisfied.

Mr. Bennett has a large refuse destructor with six cells or furnaces, each capable of burning eight or nine tons of garbage a day. Sixty cartloads of ash-bin contents are daily collected and burnt in this destructor. Twenty-five tons of refuse thus burnt generate sufficient steam to carry on the works for one day. Road sweepings are never burnt, but mixed with the sludge.

The waste heat from the destructor is also used to produce electricity. The engines drive a dynamo sufficiently powerful to feed either ten arc lamps of 3000 candle power each or 200 glow lamps for the ordinary 16 candle power type; and, frequently, four streets in the vicinity of the works have been lighted with such success that the system is to be extended.

Thus the sewage of Southampton is disposed of at a decided profit instead of loss to the town, as the sale of the manure more than pays for the works, the neighboring farms are enriched, and the beautiful bay is no longer polluted.

AMMONITE is the Name of a New Explosive which consists of pure ammonium nitrate and nitro-naphthaline. Both of these constituents are separately inexplosive. When combined intimately they form a highly explosive compound. In manufacturing this powder, the ingredients are dried and ground separately, and subsequently mixed in edge-runner mills with a moderate heat. The result is a yellowish powder which is filled into metallic cartridges by which absorption of moisture and deterioration of the explosive is prevented. It is said by Dr. Dupre, F. R. S., in a report on explosives to the English House of Commons, to be entirely free from any danger of spontaneous decomposition. It contains no picric acid and emits no injurious fumes when fired. *Invention* (London), states that it differs from dynamite, blasting gelatine, gelignite, stonite and carbonite, as well as all other explosives of the nitro-glycerine class, in its freedom from nitro-glycerine or any other liquid ingredient. Exudation and freezing are therefore impossible, and it is entirely unaffected by changes in temperature. While it is equal to roburite in explosive force, it is free from the objections which have been met with in the use of that explosive. Percussive action sufficient to detonate tonite, gunpowder, gun-cotton, gelignite, dynamite, ardeerite and blasting gelatine, in the case of recent experiments performed in England failed entirely to explode ammonite. Even bullets fired into a number of cartridges failed to explode it. A mixture containing one pound of gunpowder exploded among these cartridges also failed to explode any of them. When properly fired, however, its explosive strength is enormous. It leaves no residue after firing, and when the water-proof cartridge cases are used, it is not injured by moisture in the atmosphere. It is stated that the experiments recently performed in England, above alluded to, indicate this explosive to be one of the safest for mining and blasting yet compounded.

The Importance of the Tests now in progress at the Ordnance Bureau at Annapolis and Indian Head, can scarcely be overestimated. During the last year a series of most important results have been attained in trials of armor, ordnance and projectiles. Another series of experiments will shortly be carried out with 10½-in. plates constructed by the Bethlehem Iron Works and by Carnegie, Phipps & Co., Ltd., of Pittsburgh, further to ascertain the qualities of the Harvey plates as material for armor. We have already noticed the experiments on plates of this material. The fact that the steel projectiles used in previous tests were shattered against the armor plates tested, has led to further experiment having in view the improvement of projectiles also. A competitive trial between the Hotchkiss and the Driggs-Shroeder guns is also said to be contemplated.

The Supreme Council of the Order of American Steam Engineers, at its regular meeting held on July 16th at Syracuse, New York, elected the following officers: Recording Engineer, Charles F. Jacks of Boston; Corresponding Engineer, Frank Neal of Cincinnati; Treasurer, James E. Deas of Bridgeport, Conn.; Chaplain, William D. Carr of Boston; Senior Master

Mechanic, J. J. Wilson of Wahoo, Neb.; Members of the Board of Trustees, H. G. Connor of Philadelphia, Bernard Bowen of Boston, for a term of six years; Justice of the Court of the Order, John W. Teller of Utica; Secretary of the Mutual Benefit Fund, Charles E. Jacks of Boston.

A Canal to Connect Lakes Huron and Ontario is a project which the Canadian Government appears to be furthering to its utmost. A writer in the Pittsburgh *Item*, in discussing this subject, thinks that the completion of this work would incidentally bring about the annexation of Canada to the United States, as the whole tide of the commerce from the Canadian Northwest would flow through the provinces of Ontario and Quebec finding its outlet to the sea at Montreal. He ably maintains that the St. Lawrence would thereafter become commercially an American river and that the history of the lower Mississippi would be repeated. He, however, points out that there are great obstacles in the way of the execution of this scheme. Lake Huron is 340 ft. higher than Lake Ontario, a difference of elevation of more than twice the height of Niagara Falls, which would have to be overcome in an air-line distance of about 100 miles; and besides this there would yet remain the rapids of the St. Lawrence now flanked by 43½ miles of canals, which for the admission of large ships would require to be entirely reconstructed. The opening of mere canal boat navigation between Lakes Huron and Ontario would be easy; but the construction of a ship canal over that line would cost so much money as would be likely to involve Canada in an overwhelming debt which the United States Government would ultimately find it for its interest to assume.

The Corinth Canal, destined to sever the Peloponnesus from the main land of Greece, is said to be rapidly approaching completion. It will permit the largest ships to pass from the Gulf of Athens to the Gulf of Corinth, its width being 96 ft. and its depth 36 ft. A railroad bridge which crosses it at the Corinth end will be 164 ft. above high water, so that tall ships may pass without unshipping their topmasts. The Philadelphia *Telegraph*, in discussing this great work, estimates that 300 vessels from Trieste, about the same number from Italian ports and from 700 to 800 Greek ships will use the canal annually, and that the average tonnage of these vessels will be 1500 tons. This gives a total tonnage of 3,150,000.

Another Very Ingenious Invention, which is called Michele's Crank Device, is illustrated and described in *Engineering*, London, in its issue of July 10th. It entirely obviates a dead centre on the crank of an engine driven by the ordinary Pitman connection. The crank pin, instead of being firmly fitted into the crank or a disk used as a substitute for a crank, is fitted into a slide working in a slot, which, when the pin is on the centre, inclines at an angle of 45° with the line of centres. The crank pin is held firmly against the end of the slot by a stout coiled spring which presses against the slide. When, however, the crank is in the line of centres and steam is admitted behind the piston, the spring yields somewhat and allows the crank pin to pass either above or below this line, according as the piston is about to make either its out-stroke or in-stroke. The pin is thus thrown to one side of the line of centres, and forced towards the side in the direction of its proper motion. It therefore becomes impossible to set an engine fitted with this device so that it will have a dead centre.

The Recent Trial of Guns at Sandy Hook indicates that in the manufacture of ordnance the United States will soon be second to no other nation. Guns of 16 in. calibre are now being constructed. The gun tested at Sandy Hook, 12 in. in diameter of bore, is said to be the first rifle cannon of this calibre ever built in this country. It discharges a projectile weighing about a ton and its charge is 440 pounds of powder. Its maximum range is said to be 12 miles.

The Creosoting of Timber was the subject of a very interesting and instructive paper read by Mr. E. J. Silcock, A. M. I. C. E., F. G. S., before the London meeting of the Association of Municipal and County Engineers. It appears from this paper

that practice in England and America differs in the respect that, in this country, oils obtained from the distillation of wood are largely employed, while in England what is commonly called creosote from coal tar is mostly employed. The decay of timber is shown to result chiefly from the fermenting of the albuminoids of the sap, the admission of water into the cells of the wood and the attacks of insects. Creosote acts as a preservative against all of these destructive agencies. Wood creosote is stated by the author of this paper to be much more uniform in its constituents than coal tar creosote, less volatile when exposed to air and water, and on these accounts preferable to coal tar creosote, in the antiseptic treatment of timber. It has another advantage in its freedom from ammonia, which is generally believed to be injurious to timber. The author says that he has seen Baltic sleepers 10 inches by 5 inches which absorb over 20 pounds of creosote per cubic foot, and that there is no practical difficulty whatever in getting 10 pounds to 12 pounds per cubic foot injected into any timber of the coniferous class. As a gallon of creosote weights about 10½ pounds this would mean an absorption of that volume for each cubic foot of timber. Processes of saturating timber with creosote which do not thoroughly extract the water introduce an element adverse to durability.

An Immense Reservoir has just been completed for the South Australian Government at Beetaloo. The principal feature of interest in this work is the dam, which is of concrete and is one of the largest dams in the world, and said to be certainly the largest concrete dam in the Southern Hemisphere. About 60,000 cubic yards of cement concrete were required. The height of the weir is 110 feet, and the width on the top is 14 feet. The length is 580 feet, and the cross-section is in accordance with Professor Rankine's formula, the horizontal curvature having a radius of 1414 feet. The stone and sand required were obtained in the neighborhood, but the cement had to be imported from Europe. Machinery was employed to mix and deposit the whole of the concrete. To the western side of the dam there is a by-wash, with massive training walls, which are partly excavated in the rock on the hillside. At present the reservoir is only half full. When full the lake will be 105 feet deep at the dam, about a mile and a quarter long, and on the average eight chains wide. In places the width is much greater, as there are several long reaches; but the average width is only eight chains. The capacity of the reservoir is 800,000,000 gallons, and on the whole of the works up to date there has been expended about $2,480,000, of which amount $585,000 was spent in the construction of the dam.

The Terminal Belt Electric Railroad, the proposed construction of which has already been noticed in this magazine, has, since our last issue, become a certainty. The required amount of capital has been raised and Mr. Frank Reynolds, president of the road, has closed all the necessary contracts for the construction. The road is to be immediately commenced. As will be remembered the road is to be run from Rutherfordton, N. C., to Asheville, across the mountain by way of Hickory Nut Gap. The portion of the three counties, Henderson, Buncombe and Rutherford, through which the road is to run, is stated by the *Manufacturers' Record*, Baltimore, to be one of the richest if not the very richest district in timber, gold, iron and fertile lands in Western North Carolina. The journal quoted also states that in beautiful scenery and wonderful sights it surpasses anything in the South. Among the objects of interest in this region are Chimney Rock; Bat Cave; Shaking Bald Mountain; Hickory Nut Gap Falls; The Pools, etc.

More Whale-Back Steamers are to be built. Mr. Alexander McDougall, the designer of these boats, and the builder of the whale-back steamer *Charles W. Wetmore*, which recently sailed with a cargo of wheat from Duluth to Liverpool, is credited with saying that in a very short time the keels for ten more of these boats for service on the Atlantic will be laid. One of 450 feet in length with cabin accommodation for 2000 passengers is projected. It is intended for passenger service

during the continuance of the World's Fair in Chicago. The intention is, at the close of the Fair, to cut the vessel in halves and take it to the Atlantic. With regard to the *Wetmore*, now in New York Harbor, Captain McDougall is said to have stated that she will take on board here materials destined for the construction of two boats to be built on the Pacific Coast, which, together with a partial cargo of machinery obtained in England, she will convey to the ship-yards on Puget Sound near Seattle.

A New Water Lift designed for railway water stations and other similar purposes has been patented by Messrs. M. Burt and J. W. Skilton of Jackson, Florida. It is stated to consist of a tank, a large bucket and a well or water hole large enough to hold and fill the bucket, which may be of any desired capacity. A moving train can raise 2000 gallons of water from the bottom of a well or stream. The passing train is connected with a rope attached to a hoisting apparatus. As it moves off, the vessel, containing 2000 gallons of water, is raised from the bottom of the well, the well is uncovered, the water is raised twenty feet or more above the surface, the tank is automatically uncovered and the water is discharged into it, the cover is replaced and the vessel descends into the well, covering the well as it goes down, and is ready for use again in one and a-half minutes. All of this is done by simply attaching the rope connecting with the hoisting apparatus to the train. The rope is disconnected automatically when the water reaches the top of the tank, and the descent of the empty bucket is automatically governed so that its motion is quiet and gradual.

The Preliminary Borings which have been conducted by engineers Worthen and Parsons in order to determine the character of the strata which will have to be pierced by the proposed tunnel in carrying out the plans of the Rapid Transit Commission of New York City, have been completed, and it is stated that no serious obstacles have presented themselves. The route below Canal Street is found to be much better than was previously thought, bed-rock being further below the surface than has been commonly supposed. No quick-sand was pierced. The depth at which bed-rock at different parts of the city has been found is stated in the *Engineering and Mining Journal* to be as follows:

Whitehall Street—Front Street 20.00 feet, Water Street 23.00, Pearl Street 16.00, Bridge Street 20.00, Stone Street 21.00, Beaver Street 34.00. *Broadway*—Morris Street 35.25, Exchange Alley 51.50, Rector Street 63.10, Wall Street 60.10, Pine Street 70.00, Cedar Street 70.75, Liberty Street 70.90, Cortlandt Street 70.30, Dey Street, 76.85, Fulton Street 83.25, Vesey Street 81.50, Barclay Street 101.15, Park Place 112.50, Murray Street 113.50, Warren Street 109.20, Chambers Street 100.75, Reade Street 116.00, Duane Street 163.50, Thomas Street 138.50, Worth Street 147.60, Leonard Street 96.55, Franklin Street 83.45, White Street 105.50, Walker Street 107.20, Lispenard Street 68.25, Canal Street 87.65, Howard Street 50.00, Grand Street 70.80, Broome Street 47.75, Spring Street 70.10, Prince Street 70.00, Houston Street 105.60, Bleecker Street 66.15, Bond Street 68.85, Third Street 53.00, Fourth Street 40.10, Washington Place 34.55, Waverly Place 48.85, Astor Place 49.75, Clinton Place 65.25, Ninth Street 35.25, Tenth Street 40.33, Eleventh Street 31.15, Twelfth Street 22.00, Thirteenth Street 34.00, Fourteenth Street 13.35, Seventeenth Street 10.15, Twenty-First Street 17.00, Twenty-Third Street 21.50, Twenty-Fifth Street 24.00, Twenty-Seventh Street 19.20, Thirtieth Street 15.00, Thirty-Third Street 4.00.

The Improvement of Southern Rivers has been made the subject of a report by Major Quinn, U. S. Engineer, from which it appears that engineering operations are now in progress upon many Southern rivers of a character which will result in great local benefit. In Louisiana no less than 13 rivers, bayous and passes, are named as undergoing these improvements. In Mississippi $143,938 has been stated by Lieut. John Millis, of the U. S. Engineering Corps, as being available for levee construction in addition to what is now on hand.

Professor John M. Barr has resigned his professorship in the University of Minnesota, to take charge of the whole line of junior work in machine designs in Sibley College, Cornell University.

AN Important Company with a capital stock of $1,000,000 is said to have been organized to develop the marble beds of Yule Creek in Gunnison County, Colorado. The *Mining and Scientific Review*, Denver, devotes three columns of its editorial space to the interesting discussion of these quarries. From this editorial we learn that the location of the quarries is eight and a half miles from the present terminus of the Rio Grande Branch Railway at the Anthracite Mesa coal mines and twelve miles from Crested Butte, and that they contain the finest white and variegated marble in the world. Quoting from a report of Professor Lake, the journal named states that in one of the groups there are 450 feet of variegated marble in ridges and terraces composed of very thick strata. The variegated marble is extremely rich in shades and patterns, the tints being soft blue-gray, dove color and delicate chocolate, veined and banded with white. In other instances it is motcled or curiously patterned. Some samples have shapes resembling trees or foliage, others have a figure resembling that of bird's-eye maple. One massive ledge of pure white statuary marble is named as being 250 feet thick. It is also stated that it is very hard, very fine grained, capable of taking the highest polish, and that blocks of any desired dimension may be quarried. The assertion is made that the quality of this marble surpasses in fineness, purity and solidity that of the quarries of Carrara in Italy. Tests of the strength of this material under crushing force show that it will endure 1200 pounds per square inch without crumbling. Up to the time of the formation of the company alluded to no systematic attempts had ever been made to quarry Colorado marble. The *Mining and Scientific Review* proposes that the State Capitol now building should be finished with this material. It also states that Senator Tabor proposes to build a marble palace from these Colorado quarries and that a computation of cost shows that it will scarcely exceed that of ordinary cut sandstone. Unless these reports are exaggerated (we see no reason to believe they are) the opening of these deposits must add largely to the wealth of the State in which they have been discovered. They will doubtless add an interesting feature to the architecture of our Western cities.

The Results of Some Fire Tests of Plaster Boards conducted at the Royal Testing Bureau for Structural Material at Charlottenburg last March have been published in a recent number of the *Centralblatt der Bauverwaltung*. This building material is known as "Mack's Plaster Boards,"—also made in this country. The boards tested were only about 0.4 of an inch in thickness. The method of making the test was to determine the interior temperature by placing in models of houses containing the plaster boards metals and alloys the melting points of which are known, a sufficient number of these being used to indicate the temperatures within short ranges. The house models were then charged with split fir previously saturated with kerosene. The test metals and alloys were placed in crucibles so that they could be easily recovered and examined to determine which of them, if any, had fused. After firing the fuel in the house models and after about half an hour, some small cracks became visible, but still there

was no perceptible difference in the exterior temperature of the plaster boards. At the end of an hour and five minutes, upon extinguishing the fires, the plaster boards were found entirely uninjured. Combustible materials, as sheets of writing paper and pieces of lace curtains hung on the outside of the models, showed no signs of undue heat. An examination of the alloys placed in the house models showed that the interior temperature had been over 1000° C. These tests point very clearly to the fact that the material named is extremely resistant to the action of heat and flame.

The Words "Supervise" and "Superintend" have been the subject of several communications from Mr. A. J. Bloor to *Architecture and Building*. He claims that a discrimination ought to be made between these words and their derivatives, as "supervision" and "superintendence," which have hitherto generally been considered interchangeable and so defined in many dictionaries. In a recent communication to the paper named, he states that the editors of the New Century Dictionary, have admitted the distinction, and in their definitions assert that "the word 'supervise' often implies a more general care, with less attention to, and direction of details, than 'superintend.'" As it is easy to conceive cases wherein the interpretation of contracts might turn upon the use of these words, a clear understanding of their meaning is important.

A New System of Fireproof-Floor Construction has been described in a contribution to *Engineering News*, written by Mr. F. H. Kindl, Pittsburgh, Pa., an engineer for the firm of Carnegie, Phipps and Co., Ltd. The system has some analogy to the construction of the Monier Arch described in the July number of this magazine in this department. It is a combination arch in which the cement or fireproof material is made to take the compression strain, while tensile strain is sustained by suitable sections of steel or iron. Mr. Kindl states that the practicability of the system has been tested by an experimental floor which was found to sustain a load of 300 pounds per square foot, but it is his opinion that if the fireproof material had been closely laid together and a sufficient number of straps had been placed therein, it would have been good for 1000 pounds per square foot. These straps are metal and are placed on each side of the fireproof material, the whole being finished by pouring Portland cement over the top of the straps. This cement firmly unites with the fireproof material and thus makes a rigid support for it. The tie-rods used in ordinary methods of fireproofing floors are dispensed with. The straps are fastened directly to the beams, or, if desired, they may be fastened to the ends of the tiles, an angle iron fitted to the full length of the top corner of the tile furnishing a proper bearing to receive the pressure of the strap.

A Combined Hotel and Tower is projected, and will, according to report, be soon commenced in Chicago by the Park View Hotel and Tower Company, which has been incorporated under the laws of Illinois, and has a capital stock of $800,000. The scheme has been under discussion for several months, and it is now proposed to put the work in hand and complete the structure so as to be ready to receive occupants at the time of the World's Fair. The tower is to be 533 feet high and to be built entirely of steel. Surrounding this tower at various heights and about 100 feet apart, beginning at about 150 feet from the ground, are to be constructed balconies. The hotel proper will be below the first balcony. Its dimensions are named as 160 feet front and 125 feet in depth. Four elevators at the ground will run to the first balcony at about 150 feet from the ground. From thence upward there will be two elevators which will reach the top of the tower. The latter is to be surmounted by a globe, with the interior of which the last named elevators will communicate.

A New Apparatus for Filling Incised Letters or ornamental tracery in stone with molten lead has recently been patented, and has been described in the *Stone Mason*. From this description the apparatus appears to consist of a plate or plates divided in the centre and provided

with a receptacle into which the molten lead is poured, the plate being held level on the surface of the stone or other material over the letter or decoration which it is desired to fill with the lead. The molten lead, passing through the plate from the receptacle, flows along grooves into the spaces to be filled. A recess allows a sufficient portion of lead to project above the surface of the stone for hammering down and compensating for contraction in cooling. The recess is not sufficiently deep to allow the molten lead to flow over the surface of the stone, as the latter, being cold, chills the lead, which is retained in the letters or engraved parts. The apparatus is jointed so that the plates may open and clear the runner without disturbing the letters. The runner is afterwards nipped off with a pair of pincers, and the work hammered down and finished off in the usual way.

The Great Improvement in the Architectural Beauty of New York City during the last twenty years has formed the subject of an editorial in the New York *Times* which at the same time asserts that Boston has, during the period named, plainly been retrograding. The discussion thus initiated by the *Times* has been taken up also in the New York *Sun*, which in an able editorial shows that the improvement of the town architecturally and with respect to its pavements, water supply, means of transit, lighting and the efficiency of its police and sanitary administration, has been obvious to every citizen and every visitor. The *Sun* makes this the text for a political sermon in which it succeeds, we think, in ably defending its position, that notwithstanding the general defects of municipal government which are inherent in the nature of our institutions, it is impossible to divorce it from politics, and that a large proportion of the improvement observable in the city is due to the improvement of its municipal administration.

The "Terragraph" is a New Patented process for copying tracings, or the reproduction of original drawings, the tracing not being necessary if the original drawing is inked in and colored with special aniline inks designed for use in the process and prepared in a peculiar manner, which permits from thirty to sixty transfers to be made, leaving the original drawing unsoiled and unimpaired. The copies are permanent, and we are told are guaranteed not to fade by exposure to light. Neither climatic influences nor differences in light in any way affect the transfer, which may be done at night as well as in the day time. Moreover, the length of time which may have elapsed after inking and coloring the drawing in no wise obstructs the transfer. The scale of the drawing is retained exactly. The transfer is effected by simple pressure without moistening the paper. The process is best adapted to topographical and architectural drawing, especially in the reproduction of architects plans, maps of railways, embankments, dams, canals, etc. Copying by this process is done by Messrs. F. W. Devoe & Co., corner of Fulton and William Streets, New York, who also supply the inks and washes. The copies we have seen are greatly superior to tracings, and are incomparably superior to blue prints. Their cheapness is also not the least of their merits.

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"I find that our superintendent at —— took it upon himself to change the door stiles from six to five inches, and that the doors are all made so. As the young man is no longer in our employ, there is no redress in the matter, excepting to stand it, and we will have to use a lock suitable for a five inch stile. In the meantime hold the locks previously ordered until I see if I cannot convince the contractor that he would like to make a lot of new doors for nothing."

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Another Steel Tower is to be erected in London, the design having been completed by Messrs. Maxwell & Tuke, Manchester. The tower is to stand upon a plot of land containing 6000 square yards in a central position in that part of London known as Blackpool, and at a distance of 250 yards from the Central Railway Station. The principle of construction will be that of the famous "Eiffel" Tower. The base of the tower proper will be 100 feet square; but it will rise from a large rectangular building which is to be employed as a circus and is to contain a menagerie and an aquarium. The second floor of this lower structure will contain an area of 30,000 square feet, and above this will be two stories of open air balconies and cafés. The tower itself is to rise to a height of 450 ft. Hydraulic elevators are to be employed for reaching the cupola at the top of the tower. The principal material in construction will be steel, but wrought iron will be employed to some extent. The lattice pillars, which will form the 16 principal supports of the tower, are to be filled in and covered with Portland cement concrete which will be decorated. It is expected that the cement filling will not only beautify the tower but will also serve to strengthen it against the high winds which frequently visit that part of London.

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with a receptacle into which the molten lead is poured, the plate being held level on the surface of the stone or other material over the letter or decoration which it is desired to fill with the lead. The molten lead, passing through the plate from the receptacle, flows along grooves into the spaces to be filled. A recess allows a sufficient portion of lead to project above the surface of the stone for hammering down and compensating for contraction in cooling. The recess is not sufficiently deep to allow the molten lead to flow over the surface of the stone, as the latter, being cold, chills the lead, which is retained in the letters or engraved parts. The apparatus is jointed so that the plates may open and clear the runner without disturbing the letters. The runner is afterwards nipped off with a pair of pincers, and the work hammered down and finished off in the usual way.

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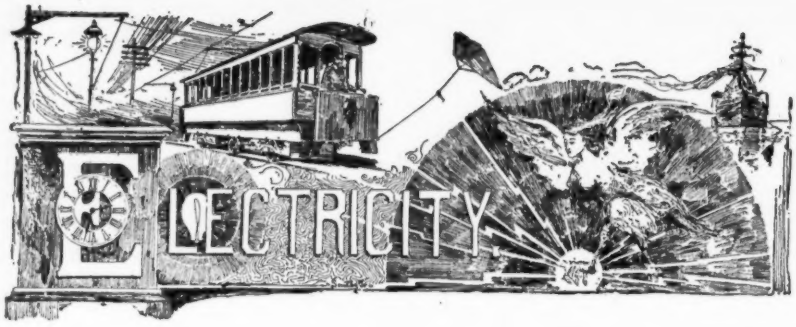

AN Interesting and Apparently an Important Application of the Alternating Current to the amalgamation and extraction of gold from ores, has been made by Dr. W. Crookes, and it appears to meet with approval from both mining engineers and electricians. Amalgamation with mercury is attended with the important defect well-known to metallurgists, that the mercury frequently assumes a state in which amalgamation is greatly retarded or entirely checked. This is called the "flouring" or "sickening" of the mercury, and appears to result from the formation of a coating of sulphide upon the particles of the mercury which effectually separates them from the gold. Whenever the mercury "sickens" there is a liability that from 30 per cent. to 80 per cent. of the gold will not amalgamate. This coating of tarnish on the mercury requires either mechanical or chemical manipulation for its removal. To avoid this difficulty the clorination of ores, after roasting them to expel the sulphur, has been extensively practised, but this is expensive. The gist of Dr. Crooke's improvements consists in the treatment of ore with a solution of mercury cyanide or other soluble mercury salt. The tarnish of the mercury is thus removed and even a slight superficial amalgamation of the surface of the gold particles is produced which facilitates further operations. Both heat and the action of the alternating electric current accelerate the action, but the alternating current produced by a dynamo machine is much preferable to heat. It is stated that by this process even the "float" and "flour" gold are amalgamated and that the efficiency of the operation does not depend upon the coarseness of the ore, the solution even penetrating to particles hidden away in the matrix. The alternating current is, however, assisted by heat in this process, because the sudden decompositions and recompositions generate heat which aids the progress of the amalgamation.

One of the New Things in Electricity is a Gas Battery which has been devised by a German inventor, Mr. P. Scharf. As described in *Invention*, London, this battery employs gases which produce a voltaic current by their mutual action. The gases are prepared in separate apparatuses and compressed into suitable receivers, whence they are conducted to the battery. The description as given in the journal cited is rather hazy. The gases named are classed into groups: 1st. Hydrogen; water gas; generator gas; coal gas; and the vapor of light hydro-carbons, such as petroleum, naphtha or the like. 2d. Air; oxygen; chlorine and fluorine. It is stated also that in some cases a liquid and a gas are used, the liquid being substituted for one of the gases named above in the second group. The management of these gases is not described, and beyond the bare fact that a voltaic current is obtained by the employment of the material, very little information is given.

The Alternate Current System of Distribution is again in litigation, and the *Electrical Engineer* in discussing the new phase of it, which now turns upon what is known as the "Kennedy" patent, regards the issues in law as being nearly as important to the electric light industry as those which were involved in the Edison incandescent lamp suit. The journal quoted

states that many had come to regard the matter as "practically settled by the defeat of the Westinghouse Company's Gaulard and Gibbs patent in the suit brought under it against the Sun Company of Woburn, Mass., and decided by Judge Colt in 1888." It now turns out that the Westinghouse Company had become possessors of Kennedy's patent dated July 16, 1889, an application for the reissue of which was filed August 28, 1889. This patent, which now becomes very important in connection with this phase of the litigation is printed in full (both text and drawings) in the *Electrical Engineer* of the 29th of July. The inventor states in the declaration in his specification, that he has "found that a counter electromotive force is set up in a coil of wire carrying an alternating current and wound upon an iron core, and this counter electromotive force is proportionate to the size of the iron core and the length of the wire in the coil surrounding the core." He states further that he has "found that when the secondary circuit of a properly constructed secondary generator is opened or disconnected and an alternating electric current is applied to the primary coil, a counter electro-motive force is developed in the primary coil which is practically equal to the applied electro-motive force. When, however, secondary currents are allowed to develop in the secondary coil, the counter electro-motive force is so modified that a primary current flows which varies approximately inversely as the resistance applied to the development of the secondary current." Availing himself of this discovery he states further that he has "devised a new method of distribution of energy or alternating electric currents by which the secondary generators are rendered independent and self-governing, each receiving its appropriate current independently of all the others, and each deriving from the source an amount of energy proportionate to that which is actually consumed in the secondary circuit." Much of this will be unintelligible except to professional readers. It is introduced merely to show that Mr. Kennedy made a real discovery, and that his patent is based upon it. This discovery enabled him to obviate two difficulties which had hitherto existed, one of which was that a variation in the resistance opposed to the position of the current through any one primary coil produced a corresponding variation in the current flowing through the primary coil of all the other secondary generators. The other was that the opening of a secondary circuit of any of the secondary generators greatly diminished the current delivered to all the others, so that by turning off the lights at any one point the entire system would be disturbed. Mr. Kennedy's claim is, broadly, for a *method*, and appears to be extremely well drawn. The Westinghouse Company will be able to make a strong fight upon it. The progress of the litigation will be followed with great interest in electric circles.

The Effect of the Electric Current on Evaporation has been very ably discussed and experimentally displayed in connection with the reading of a paper by Prof. William Crookes before the Royal Society at its meeting of June 11, 1891. A method of coating glass surfaces by the passage of an electric current through platinum electrodes has for some time been well-known and practised by the manufacturers of physical apparatus. Dr. Crookes takes the view that volatilization through the agency of electricity corresponds very nearly to evaporation as produced by the agency of heat. Evaporation from either of these agencies is caused by a lessening of the cohesive force of the particles of the substance heated or electrified. There appears to be, however, a distinction between the action of heat and electricity in the volatilization of solid bodies. For instance, it is shown by Dr. Crookes that while platinum would require the application of a very intense heat to separate molecules of its exterior stratum from those of the interior, this separation will take place with only a very moderate amount of negative electrification. He also shows that the law that evaporation takes place more rapidly *in vacuo*, applies equally to evaporation by electrification. It may be supposed that this effect would be shown more strikingly

with water than with metals, but the contrary is the case. The effect is shown to be very much greater at the negative than at the positive pole. In fact, Professor Crookes shows that the distributing influence which increases the evaporation even at atmospheric pressure is peculiar to the negative pole. Negatively electrified water lost in one and one-half hours, 0.001 part of its weight more than did insulated water. Six grains of cadmium were placed on each of the positive and negative poles, and in 35 minutes there were remaining on the positive pole 3.65 grains, while upon the negative pole there were only remaining .25 of a grain. Nineteen times as much silver was volatilized from the negative pole as from the positive pole.

The Barbarity of the Word *Electrocute* exceeds by far that of the process of killing which it indicates. A great number of other words have been suggested, and a writer, who signs himself a teacher of Greek in the College of St. Francis Xavier, in New York City, has contributed an interesting and scholarly discussion of the subject to a recent number of the New York *Sun*. He claims that the hold on the language which the word "electrocute" has attained is due to the very criterion that has made the proposed substitutes unpopular. He states the problem as being "to find a word terse in form, correct in composition and precise in meaning, which will convey the idea to administer electricity so as to cause death." In the solution of this problem he starts with the word *electron*, to which some other word must be added. *Electrothnate* is shown to be faulty in having "the Latin ending 'ate' joined to the mangled remains of the Greek 'thanatos,' in addition to which it has two principal accents. *Electrophony* means electro-slaughter and has not a verbal form. The writer also points out that it resembles too much compounds of "phone," voice. *Electromorsion*, meaning electro-death, is not the active verb wanted, and, besides, there is no Latin word *morsis*. *Elexecution* is dismissed by this learned writer with the simple remark that there is nothing to be said about it. Then he goes on to point out that we have in the language the precise word—*electrize*—which conveys "the generic idea of administering electricity to." This word he shows to be thoroughly Greek in stem and termination. It has the further advantage that it is as short as the root noun. *Electrify* he claims to be but a mere hybrid only employed in English. The French analogue of the English *electrise* is *electriser*; the Spanish, *electrizar*; the Italian, *elettrizzare*; the German, *electrisiren*; and the modern Greek, *electrizo*. The word, however, leaves a new element which should take the form of a prefix. *Thanat-electrize* would be accurate but unwieldly. The author arrives at the simple solution of the problem by using the Greek preposition *kata* as a prefix, thus deriving the easily spoken and euphonious word "katelextrize" from which the equally brief and correct accessory forms "katelectrist," "katelectrism" and "katelectric" are at once obvious. These words will at once meet the approval of good taste and judgment on the part of all scholars. If we are to have execution by electricity they should be adopted.

The Poor Man's Lamp, is a phrase which was used by Mr. W. H. Preece, F. R. S., in an address delivered before the Incorporated Association of Municipal and County Engineers at the Institution of Civil Engineers, London, on a recent occasion. He applied the phrase to the electric light. It was the purpose of his address to prove that the electric light is not merely the light of luxury, but "the poor man's lamp." He stated that he had just been making an exhaustive inquiry into the cost of production of phosphorus and copper, in which continuous currents are employed, and that in any case where the load line is constant, as in the production of copper and phosphorus, electricity can be produced at a cost of one-third of a penny per unit. "There is no mistake about that figure," said Mr. Preece. "The cost of production of a unit of electricity with a constant load is but one-third of a penny. What does this mean? If we take the theoretical difference between gas and electricity, it is equivalent to gas produced at 3d. per thousand feet. When we have

the prospect of producing electricity at one-third of a penny, equivalent to gas at 3d. per thousand feet, it shows what a vast field of development is before the electric light. There is one reason why gas is still ahead of electricity; it is that there is such a market in this country for residuals. The price obtained for coke and ammoniacal liquors, and the other ingredients of gas works, practically reduces the price of coal in London to the gas manufacturers to 4s. 6d. per ton. We have to pay in London for Welsh coal 23s. per ton; that is why we have to pay more for the electric light than for gas. When we come to places like Gibraltar and Malta, where I went to see whether it was possible to use the electric light instead of gas, where there is no market for residuals, it required no difficulty on my part to say that it was possible to produce electricity cheaper than gas. I have endeavored, to the best of my ability, to bring this matter before you as practical men, and I want you, if you agree with my conclusions, to point out to your different boards that the duty of a corporation is to look into this matter, not only from a financial, but from a political as well as a sanitary, but, above all, from a philanthropic, point of view, and endeavor to persuade, as I have endeavored to persuade you, that the electric light is not the light of luxury, but the poor man's lamp."

A New Departure in Electric Engineering has been initiated by the recently organized firm, H. Ward Leonard and Company. Mr. H. Ward Leonard, the General Manager of the Light & Power Department and also of the Intelligence Department of the Edison General Electric Company, resigned on August 3, in order to start an independent electrical engineering business. The company is incorporated under the laws of the State of New Jersey. Mr. Leonard will take with him several well-tried assistants who have been associated with him in the past, some of them as far back as 1885. Among these are Mr. A. St. C. Vance, M. E. H. Harrison, Mr. C. H. Bloomer and Mr. August Munning. The company will operate specially in a field at present inadequately occupied, namely the transmission of power by electricity and the application of electric motors to the operation of special machinery, not at present operated by electric motors or machines susceptible of improvement by application of skillful engineering. Mr. Leonard's experience on Mr. Edison's Electrical Engineering Staff has brought him into contact with every branch of electric light and power work. One important feature of the new business is entirely unique, namely an Electrical Intelligence Department. To any isolated plant, the company offers at a very moderate subscription price ($25 a year) the privilege of corresponding upon any electrical subject of practical interest. Thus, an isolated plant will be able to secure expert information either as to its own plant and the best methods of operating it, or about new electrical apparatus, methods or principles underlying various devices. For Central Station Companies, whose queries would go further into Steam Engineering and methods of distribution, and would also cover business questions as to relations with consumers, systems of accounts, etc., the annual subscription charge for this Electrical Intelligence will be $50. The company will do no manufacturing or supply business, neither will they, under any circumstances, act as the selling agents of any concern directly or indirectly. The staff will, however, act for the purchaser, either as Consulting Engineers, Supervising Engineers, Inspectors or Purchasing Agents. The company will also make a specialty of the transmission of power and the application of electric motors to such uses as necessitate the application of a wide experience in both mechanical and electrical engineering, as elevators, pumps, hoists, mine tramways, printing-presses, etc.

An Important Discovery, if confirmed, has been announced in Vienna. As promulgated, this report states that a Captain Walter has discovered a method whereby glass, amalgamated with some kind of metal besides platinum, may be used in the manufacture of electric lamps, thus largely reducing their cost. The announcement is extremely vague, saying nothing of the nature of the metal employed.

JADE, otherwise called Nephrite, of which the variety known as Jadeite is the most valued kind, is a silicate of aluminium and sodium having a color varying from white to pale or dark green or gray-green and translucent. This mineral attracted attention shortly after the discovery of America, being then brought to Europe in the form of carved ornaments from Mexico or Peru, it is uncertain which. The Mexican *Mineralogy* of Del Rio mentions this mineral but names no locality from which it is derived. A similar stone comes from China. It is, according to Dana's Mineralogy, a tough, compact, fine-grained tremolite, with a tinge of green or blue, breaking with a splintery and glistening lustre. The name "nephrite" is derived from its formerly supposed efficacy in curing diseases of the kidneys. Dana states that it is generally found associated with talcose or magnesian rocks. The most singular thing connected with the history of this material is its wide distribution in parts of the world where no natural deposit is known to exist; for instance, ornaments of it have been found in the Swiss lake dwellings. The jade from which these ornaments was made has been generally supposed to have been brought from the East. The ancient Mexican name *chalchihuitl* is thought by Pumpelly to be the same mineral as the *feitsui* of China, the latter being a fine quality of jade and asserted to be the most valued of all the stones among the Chinese. The best jade has been obtained from Kara Kash Valley in Turkestan. Implements of jade are also found in Central America, the Pacific Islands, New Zealand and Alaska, and, from the fact of this mineral having been much used for axes in the stone age, it has been called "axe-stone." The principal known deposits of this mineral have been named above, and the question naturally arises, whence and how has its distribution among barbarous and savage races over the face of the earth been accomplished? Many ethnologists have believed that the material is more widely distributed in nature than our present knowledge indicates. The subject has been recently revived by Mr. Adrian Jacobson in the *Globus*, Brunswick, for June. This gentleman has made collections in Alaska, the Prince of Wales Peninsula and on Kotzebue Sound and has obtained about eighty objects ranging in color from white to dark green, including axes, chisels, crescent-shaped knives used in skinning animals and dressing fish, little sharp knives for making wood and bone articles, boring implements and hammers, a large broad dagger, ear-drops, lip-ornaments, rod-shaped amulets, etc. He says that whenever he asked the natives where they got the jade they gave uniform answer that it came from the high mountain near the Kowac River, which empties into Kotzebue Sound. He says moreover that a guide acually offered to take him to the spot. He infers, from the fact that the jade ornaments and tools have the same character as other stone utensils used in the district where they are found, that they were produced in the region where they were collected. In another place he states that he was told by Esquimaux that two men made a business of cutting out jade on Kotzebue Sound and selling it to the people.

The Eleventh Census a Failure, is what our able technical contemporary *Stone* states to be nearly the unanimous opinion. It backs up this statement by a very severe criticism on the June Bulletin of the

Census Bureau relative to limestones. It charges, that in this report the Indiana stones have either been ignored or only casually mentioned. It is well-known that almost the only commercial supply of oolitic limestone on this continent exists in Indiana, and that this stone is considered by many to rank at the head of all limestones as a building material. Certainly this ought therefore to have been mentioned in a Bulletin specially devoted to limestone, but it is not mentioned even casually. The editorial in *Stone* is extremely caustic and a few of its remarks will justify quotation not only on account of their pertinence but their witty sarcasm. In one place the editor states that it would seem to the editor of the Census Bulletin that his only idea of limestone is "a stone from which lime is made," as the census reports give more importance to lime, than to building stone. *Stone* points out also that the same weakness was manifest in the Bulletin on granite. Among other things the writer of the article says that in this Bulletin: "The Indiana State House, the Soldiers' Monument, the Auditorium of Chicago, the House of the Algonquin Club, in Boston, and hundreds of other fine examples of architecture, all built of oolitic stone, are merely subjects for the lime kiln, worth 12 cents or less per cubic foot. The same iconoclast would see in the Venus of Praxiteles only a few pounds of lime, worth possibly a quarter of a dollar. The Parthenon of Athens thus becomes only a quarry for cement, and one of the most important industries of a great State is reduced to the level of the gravel pit in a work intended as the exponent of the industries of the ninth decade of the nineteenth century. In short, the eleventh census is a failure, and the effect of the failure on the future of these industries is but little removed from a crime."

The New-Form Siemens Furnace is attracting much attention abroad. One has been erected at the Lather Iron Works, near Glasgow, and is kept fully working, the results obtained at these works being so satisfactory as to have led to the commencement of the erection of other works in various places. Mr. John Head has communicated to *Engineering*, London, some interesting facts relative to the puddling of gray iron in the furnace at the Lather Iron Works. These facts reduced to tabular form are printed below:

—	"Coal-fired" Furnace. (Single Puddling) during 10 Shifts.	New Form Siemens Gas Furnace (Double Puddling) during 7 Shifts.
	cwt. qr. lb.	cwt. qr. lb.
Pig mental charged.....	346 0 20	484 1 1
Yield of puddled bars....	328 0 13	445 1 24
Loss of metal.....	18 0 7	8 3 4
	=5.2 per cent	=1.9 per cent
Scrap balls (bars) made...	14 3 10	37 0 2
Yield of iron per shift....	34 1 5	71 1 19
Coal used (including lighting up)	410 0 0	149 1 0
Coal used (including lighting up) per ton of iron made.....	23 3 9	6 0 22
Coal used per ton of iron made (exclusive of lighting up).....	22 2 26	5 2 7
Fettling used per ton of puddled bars.....	6 2 2	3 0 0
Cost of fettling per ton of puddled bars.....	s. d. 3 11	s. d. 2 2
Cost of repairs per week..	15 0	estimated at £s.

The mixture of pig iron used was the same in both furnaces, and the puddled iron made in the gas furnace was distinctly superior to that made in the coal furnace, the rolled bars being cleaner and more free from rough edges The puddled bar was regularly produced from gray pig with a consumption of 6 cwt. of fuel per ton of iron, as compared with 23 cwt., 3 qr., 9 lbs, in puddling the same mixture of gray pig iron in the grate furnace. Mr. Head also gives the following estimate:

"To puddle, say, 40 tons of gray pig iron in grate furnaces with boilers attached, and to puddle the same weight of the same pig iron and raise the same quantity of steam in the new-form Siemens furnace, the figures will stand as follows:

"40 tons × 23 cwt. 3 qr. 9 lb. = 953 cwt. 0 qr. 24 lb. coal, which weight of coal will evaporate, at 2.85 lb. per pound of coal used, 2716 cwt. of water; to do the same work in the the new-form Siemens furnace will require (40 × 6 cwt. 0 qr. 22 lb.) = 248 cwt. of coal for puddling, and 339 cwt. for raising steam, or a total of 587 cwt., showing a saving of 39 per cent. in fuel in favor of the new-form Siemens furnace."

The Dangers of Explosions from Firedamp have been reduced by a new system introduced by M. Raveaud. In carrying

out this system M. Raveaud divides a mine into four parts and makes in each quarter of the mine two chimneys or shafts, starting from the surface and terminating in the workings. One of these pair of shafts is arranged to take in fresh air and the other acts as an outlet of air from the mine. So far, the system would seem to be one of ordinary ventilation by air shafts, but there are other peculiarities in the system. The shafts which are 40 inches in diameter communicate through the galleries which constitute distinct blocks. Water and air-tight doors, protected from fire by metal sheets, isolate each quarter, of which the aeration is effected by the chimneys. According to the deviser of this project, if a fire-damp explosion occurs, it would be restricted to the quarter in which it originated, and by the arrangement of doors, etc., the force of the explosion would be confined to that part of the mine and the shafts, which would offer an immediate outlet for the gases. The other portions of the mine would, it is maintained, be unaffected.

The "Gregory-Bobtail" is the somewhat peculiar name by which the first gold bearing lode discovered in Colorado and the Rocky Mountains is now known. The *Mining Industry and Tradesman* in giving an account of the mines in Gilpin County states that the discovery of the Gregory-Bobtail was rapidly followed by the finding of Bates, Hunter and scores of others, but the original mine is still being worked. The veins in Gilpin County are principally located in an area four miles long by two miles wide, beginning at Black Hawk and extending westerly to Nevadaville. North of this region, for about six miles, there are some scattered gold and silver bearing veins, but none of them are very productive until the northern limits of the county are reached at a distance of about six miles north of Black Hawk. At this point are located the Perigo, Gold Dirt and Stewart veins, which at one time were valuable, but which owing to litigation and other causes are now idle. It appears that the ore deposits in this region have peculiarities which do not apply to others. The article to which we have referred names as maxims for Gilpin County only, the following which will be interesting to miners and metallurgists:

1. A vein which had an ore body on the surface can be depended upon to have ore at all depths below the cap.

2. Veins which had large bodies or rich ore on the surface will have large bodies or rich ore below. And *per contra* those which had small bodies or poor ore on the surface will have small bodies or poor ore below.

3. Ore does not increase in value with depth, and the man who bases his expectations upon its doing so is doomed to disappointment.

4. The ore does not change in character with depth.

5. Little danger need be apprehended from an unexpected influx of water, as the mines are nearly all dry mines.

6. The veins are continuous to all depths.

The New Siemens Puddling Furnace has been introduced at an iron works in Bilboa, Spain. The power for blowing engines and for the rolling mills is to be obtained from water wheels, a very large water power being available at this point. It is expected that the introduction of this furnace will lead to the substitution of the Siemens System for other furnaces at these works.

Steel Girders as Supports for Roofs of Colliery Workings have been introduced in Staffordshire, England, as a substitute for timber; and the change has been found so profitable that steel girders are now being manufactured and employed economically for this purpose. One large colliery is stated to have employed 1200 of them. While the steel supports are of course more costly than timber, the labor of their erection is less and their durability is very much greater. It is stated that, in some of the Staffordshire mines, timber supports will not last more than six months without rotting, while the steel girders are good for from three to five years. The change has been made on account of the results obtained in the experimental use of some of these girders for two years. It is also asserted that steel pit-props are being substituted for wooden ones.

Deposits of Coal in Washington are stated in a bulletin of the State Board of

Trade to be greater in quantity than the aggregate of all the deposits in the Atlantic States. From this bulletin we gather that the workable coal strata exceed 1,000,000 acres. Of this large field 16,000 acres is already being worked. 1,750,000 tons was the out-put of 1889. This year it is expected that no less than 2,250,000 tons will be taken out. The product of veins covering about 30,000 acres and numbering 60 will be added to the yield of 1892. The quality of the coal is various. Some of it is said to be a true cannel, containing 88% of volatile hydro-carbons and between this and a soft coal containing 91% of fixed combustible carbon are found the different grades. To this may be added 800,000 acres of lignite of which 1,000,000 tons were taken out in 1890. The producing cost of good coal mined and delivered at Puget Sound is stated to be $2.50 per ton and in San Francisco $5.

A Stroke of Luck is described in a Western exchange as being a notable event in the history of the Cortez Mines in Nevada. The story is told of one Simeon Wendban, who, at great expense, ran the Garrison Tunnel, and after having accumulated an indebtedness of $150,000 found not a pound of ore in sight. After the mine had been closed Wendban is said to have drilled a hole in the hanging wall and blasted out a huge piece of rock. This proved to be almost a solid block of metal and a part of a rich vein to which the tunnel had been running parallel for a long distance. This discovery changed his circumstances at once from poverty to wealth. The *Central Nevadan* states that the first month's run of his little mill gave him $30,000, and that the mine is now the best paying property in the State.

Copper Ore, very rich in gold and silver, is said to have been discovered on a tributary of the Little Salmon River in Idaho County, Idaho. A correspondent in the New York *Sun* states that this discovery has drawn many prospectors to that section. A serious obstacle to the rapid development of the mines is stated to be the lack of wagon road communication or even trails over which pack animals may pass with safety. In Alturas County, in the same State, very rich gray copper silver ore has been sighted and a fine mine is expected to be developed there. The ore is very rich, some of it being stated to have turned out 137 ounces of silver per ton with 26 per cent. of lead. One vein is said to have yielded 248 ounces of lead per ton.

Low Grade Gold Ores, which a few years ago would not have been considered as profitable to work, are now worked with good results. In Georgetown, New Mexico, several mines have been leased for the purpose of working low grade silver ores. In Butte County, California, abandoned claims are being taken up, the ores yielding from 25 to 40 dollars per ton, the cost of extraction being stated to be less than 5 dollars per ton, thus leaving a very handsome profit.

The Cinnabar Deposits of the New Elgin Creek Silver Mines in Colusa County, California, are claimed to be the richest in the State. Recently a tunnel was opened into a deposit stated to contain 20 per cent. A correspondent of the New York *Sun* states that the superintendent of these mines, who formerly worked in the New Almaden mines, thinks that these deposits promise to be richer than that famous mine. The smelting at the New Elgin Mine is expected to be done by the use of natural gas obtained from a well that has been burning for 25 years on the side of the mountain.

A New Copper Steel Alloy is produced by a French metallurgical company by a new patented process, and is made either in crucible or on the open hearth. It is the purpose of this company to apply the metal to the manufacture of cannon, armor-plates, projectiles and other war material. The process consists in employing ordinary copper or copper pig, avoiding oxidation of the copper before its alloy with the steel. The copper or the copper pig is introduced either at the commencement of the fusion in the interior of the bath protected by the bed of dross, or at the end, in the moment of adding the recarbonizators. By this method is obtained a steel containing from two to four per cent. of copper, and which is stated to possess remarkable qualities of elasticity, resistance and malleability.

A NEW Rotary Expansion Steam Engine which has been invented by Mr. A. F. G. Brown, of Lwinridge Muir, Dalry, Ayrshire, Scotland, has been built by John Lange & Sons, of Johnstone, England, and has been tested by Prof. Jamieson. The results of these tests were seemingly very good indeed, and the English papers have had considerable to say about them. It appears that on a series of trials of five consecutive hours each, the engine gave 29 indicated horse power with an initial steam pressure in the cylinder of 80 pounds. It was also stated that the feed-water used for each indicated horse power was only 27.2 pounds, which, so far as we know, is the best economical result ever yet obtained in a rotary engine. However, when the engine was tested by brake, it was found that a mean of only 20.78 horse power was delivered, so that while the indicated horse power is high the mechanical efficiency is also extremely low and the amount of evaporation per horse power delivered, as determined by the brake, was 38 pounds, or considerably more than 30% over what the indicated horse power showed. In this connection it may be stated that the celebrated inventor, George Westinghouse, is reported to be engaged in the solution of the rotary engine problem, and that the wide discrepancy between the indicated horse power and the power delivered as indicated by Prof. Jamieson's tests, above described, will, he thinks, be removed by a device of his invention. This consists in a bushing entirely surrounding the pistons of the engines and rotating with them in the cylinder, a very minute distance being maintained between the bushing and the walls of the cylinder, and this space being packed with steam. It would be folly to predict in advance the results to be obtained by this arrangement. The success which has met Mr. Westinghouse's now famous steam engine, encourage the belief that he may succeed in greatly improving the rotary engine.

The Circulation of Water in Steam Boilers and the cause of priming have recently been discussed to a considerable extent both in this country and in England. Two entirely opposite views have been taken. Mr. Ward Stone in the *Scientific American* has taken the ground that the escape of steam from water in a boiler is analogous to the cyclonic motion of a whirlwind and acts in the same way as air in motion when producing a water-spout. He thinks that in this way the water is carried up in the dome of the boiler, and more or less of it discharged into the steam pipes which lead to the engine. But this appears to be pure speculation. The examples of vortex motion cited by Mr. Ward to sustain his position do not appear pertinent. The conditions of the escape of water from the bottom of a bucket or basin through a hole, or the formation of a storm centre under low barometric pressure, present conditions very different from those characteristic of the mixture of steam and water in a boiler when steam is generated. We rather incline to the opinion of Mr. Adam Miller,

who, in a communication to *Engineering*, takes the ground that the movement or motion of water in any boiler while generating steam is simply that of ascending and descending unless there are obstructions to this motion which cause it to be diverted, as the use of baffle plates, circulator plates, etc. The writer of this paragraph has often experimented with the generation of steam in glass vessels, allowing the steam to escape through a central upper opening, as a glass tube placed in a cork. A wide flask having a narrow neck with a cork, and a tube inserted through the cork for the escape of steam, is an arrangement quite analogous to that of a boiler with a steam dome when the flask is filled to within a short distance from the neck. When heat is applied to such a flask and when some particles of floating material, as sawdust, are placed in the flask, so that their motion will indicate the motion of the liquid, no such action, as is described by Mr. Stone, is perceptible. The action is that described by Mr. Miller. Simple ascending and descending currents are formed and this action goes on until steam is generated. At this period steam escapes from all parts of the surface and no whirling motion is produced. There are two principal causes for the priming of steam boilers, and we think they are sufficient to account for all the phenomena attending it. First, the water may contain some viscid material, as soapy matters, oils or other material held in solution or suspension. This will cause a boiler to foam when steam is generating; but the more frequent cause is a greater demand upon a boiler for steam at times than it is capable of producing without foaming. The action in such cases is a sudden reduction in pressure, and it is not necessary that this reduction should be so large as to be notable on the pressure gauge. A fraction of a pound is sufficient. This sudden reduction in pressure causes a sudden increased generation of steam, precisely as the removal of a cork from a bottle of fermented liquor charged with gas will immediately cause the contents to foam and rise up. There hardly exists a boiler that could not be made to prime by a sudden and sufficient release of pressure; and there is probably no boiler (however, badly it may be constructed for practical use) in which priming could not be prevented by a sufficient reduction of the demand upon it for steam. Many boilers are constructed in such a way that if they produce the amount of steam proportionate to their heating surface, the passages by which this steam can gain access to the steam space are not adequate for the quiet escape of the steam. Such boilers will invariably foam when an amount of steam is taken from them such as they should be able to produce with their amount of grate and heating surface, and as such boilers are usually rated with reference to their grate and heating surface, they nearly always give trouble in use, because their owners are not satisfied to let them work beneath their rated capacity.

Heavy Boiler Steel that cannot be flanged at right-angles, with a fairly large radius in the corner, when red-hot, without injury, is, in the opinion of a contributor to the *Engineer and Iron Trades Advertiser* (England), not fit to build boilers with at all. This writer states that he has flanged 1000 large shell plates without returning to the makers more than 2 plates which showed slight surface tearings on being flanged. He asserts that ordinarily good mild boiler steel will stand this flanging in a perfectly satisfactory manner. As to local heating, he thinks there is probably a great difference in effect on the plate between heating along the edge and heating locally toward the middle of the plate. The evident large experience of this writer would seem to fortify his opinion. However, he considers it a wise precaution to anneal the plate after the welding and flanging is completed, and before any riveting is done. His method of doing this is to lower the shell-rings, flange downward, into an annular furnace heated to red-heat, and there allow the shells to remain until they are cooled down with the furnace.

A Very Desirable Improvement in Water Gauges was recently brought to the attention of the Northeast Coast Institution of Engineers and Ship Builders in Eng-

land by Mr. H. Gray. It is the invention of Mr. D. B. Morison of Hartlepool. It is designed to obviate the danger from the bursting of gauge glasses which has lately been accompanied with some serious accidents in the case of marine boilers carrying the high pressures now common in marine engineering practice. It is an arrangement whereby, when the glass breaks, the cocks, which are situated respectively in the connections (one at the top and the other at the bottom of the glass) will both be simultaneously and instantaneously closed. This is done by a small cylinder and piston connected with the water column, the piston rod of which extends out and is connected with the levers of the cocks, but in which, when the glass is intact, the pressure is completely balanced. When the glass breaks, however, the pressure on one side of the piston is immediately relieved, and the action of the piston, which is then driven upward, closes the cocks and immediately shuts off all communication from the water column to the glass. The device is extremely simple and must, we think, be entirely effective for the purpose.

A Very Ingeniously Constructed and yet Simple Fence Gate has been designed by the Eureka Gate Company, of Waterloo, Iowa. It is both light and strong, extremely durable and readily adapted to wire fences. It consists of a piece of iron pipe bent in the form of the letter Z, laid in a sidewise position, the diagonal part being connected to the vertical parts by short iron braces, and the intervening space being filled in with barbed wire. The frame of the gate is constructed therefore entirely in one piece with the exception of the short iron braces mentioned. The angles at the bends are gracefully rounded and the gate when completed is elegant and light in appearance.

A New Style of Cross-section Paper, designed by Professor J. Burkitt Webb, of Stevens Institute, has been brought to our attention. The designer names it Co-ordinate paper, from the fact that the accurate lines ruled across it may be used as co-ordinates in the tracing of curves of any kind, as theoretical expansion curves in steam engines, air engines and gas engines. The paper is printed with an olive-colored ink, which when a photograph of a tracing or curve is made from the paper also reproduces the intersecting cross line or co-ordinates. One of the distinguishing features of this paper, as compared with other cross line paper, used for the same purpose, is that the ruling is done with such accuracy that measures can be very precisely set off upon it. The lines are moreover very thin, yet distinct.

The Durability and Strength of Tubular Frame Wagons as they are called in England, or freight cars as we should call them in this country, having been assailed by a correspondent of *Engineering* (London), who signs himself "An Unconverted Englishman," an American correspondent, an engineer, formerly in this country but now residing at Christophstrasse, Cologne-on-the-Rhine, challenges the assertion of "The Unconverted" and relates the following incident relating to this class of freight cars which occurred at the time of the great flood at Johnstown to sustain his challenge. The following quotation contains his statement:

"As I was foreman in the works that were building these wagons for several years, I cannot let such an unjust statement go unanswered. The only wagons we ever had returned for repair up to the time I severed my connection with the company were six, which were loaded with all they could hold and placed on a railway bridge crossing the Junietta River in Pennsylvania, at the time of the Johnstown disaster, to keep the bridge from being washed away. The bridge went, and so did the six wagons, with many others of other construction. These were taken out, and four of them sent to the works on their own wheels, the other two being loaded upon them. These wagons were repaired at small cost and put into service again within three days, and they were the only wagon frames washed away that were even worth taking out of the river. I have never seen, and never before heard of one of these wagons being injured by shunting or by trains running into them. If the "Unconverted Englishman" had stopped to think of the thrust that eight 3-in. tubes ⅜ in. thick and 33 ft. long, clamped together every 3 ft. with strong malleable iron claps, would stand from a blow coming end on, he would never have made the statement he has made in his letter to you."

Manganese Steel was exhaustively discussed in a paper read at the Providence meeting of the American Society of Mechanical Engineers by Mr. H. M. Howe. In this discussion the subject of the difference of the wearing properties of manganese steel as compared with other steels was shown to be very great. The following tables exhibit this difference. It will be seen that a comparison was made with various kinds of steel, and that only the blue tempered, hard, tool steel shows a smaller loss in weight under wear. A table is also appended showing the effect of abrasion by an emery wheel:

TABLE I.

ABRASION BY A HARDENED STEEL SHAFT.

Loss of weight of manganese steel..... 1.0
" " " " blue tempered hard tool steel.....0.4
" " " " annealed hard tool steel...7.5
" " " " hardened Otis boiler plate steel..... .....7.0
" " " " annealed Otis boiler plate steel.....14.0

The advantage of manganese steel is much less striking when it is exposed to abrasion by an intensely hard substance, like emery. This is shown in Table II.

TABLE II.

ABRASION BY AN EMERY WHEEL.

Loss of weight of hard manganese steel wheels.....1.00
" " " " softer manganese steel wheels.....1.19
" " " " hardest carbon steel wheels 1.23
" " " " soft carbon steel wheels2.85

The Danger of Caulking Leaks in the Joints of Steam Pipes under Pressure has been emphasized in an accident which recently occurred and which has been communicated to *Power-Steam* by one of its correspondents. The plant in which the accident occurred is not named. The correspondent writes that the "man in charge of this plant climbed a ladder to caulk a leak in a joint of a 14-inch steam main, under pressure of 55 pounds. After two or three blows with hammer and tool the joint burst, the pipe pulled apart and the full force and volume of a 14-inch main pipe caught the man in face and body, literally cooking him. He lived but a few minutes. Since taking charge myself, I learn the man was a steam fitter, but took the position as chief engineer at the request of the contractor who put the plant in."

A Cement that it is said will stick to anything, is credited to Prof. Alexander Winchell. The recipe has been given in the *Jeweler's Weekly*, and is as follows:

"Take two ounces of clean gum arabic, one and one-half ounces of fine starch, and one-half ounce of white sugar. Pulverize the gum arabic and dissolve it in as much water as the laundress would use for the quantity of starch indicated. Dissolve the starch and sugar in the gum solution. Then cook the mixture in a vessel suspended in boiling water until the starch becomes clear.

"The cement should be as thick as tar and should be kept so. It can be kept from spoiling by dropping in a lump of gum camphor, or a little oil of cloves or sassafras. This cement is very strong indeed, and will stick perfectly to glazed surfaces. It is good to repair broken rocks, minerals or fossils. The addition of a small amount of aluminum will increase the effectiveness of the paste, besides helping to prevent decomposition."

The Attempt to Make Adjustments of Bolts or Nuts or to tighten boxes in machinery when running is the cause of numerous accidents. The *Timberman* calls attention to the fact that the slipping of wrenches in the attempt to tighten bolts or nuts near cutter heads, has been the cause of a great many accidents in which fingers have been lost or other injuries to the hand have been sustained. It gives the caution (which if stated in a general manner would be applicable to a great many other kinds of machines) that whenever a bolt or nut in close proximity with the cutters needs adjustment, the machine should be stopped and then no chances of accident will be taken. It also adds to the above caution another, to wit, that in setting knives and cutters on planing machines, every bolt and nut should be carefully tested before starting the machine, as if any have been omitted and are not attended to in time, this neglect may lead to a serious accident.

THE Present Number of THE ENGINEERING MAGAZINE closes its first volume, an index to which will be supplied in our next number.

At Least a Temporary Triumph over those who have sneered at the Rainmakers has been achieved. Gen. Dyrenforth and his staff of cloud compellers are said to be jubilant over the apparent success of their experiment near Midland, Tex., on the 19th August. They fired off dynamite in the air and powder on terra firma, and rain fell. Rain, though unusual at this season, might have fallen had the dynamite and powder still remained the property of ths Agricultural Department. It is significant that the ranchmen and local weather prophets are stated to believe that the fall of rain had no dependence upon the explosions. A mere coincidence cannot be accepted as proof of dependence except it be found by many succeeding experiments that the explosions and the supposed effects uniformly coincide.

The Electric Street Railways of Boston have proved so satisfactory that it appears to be the unanimous expression of the Boston newspapers that Boston has now the best equipped electric street railway in the country and the largest revenue mileage. *Light and Heat* states that the West End system transported last year 114,000,000 passengers. The carrying capacity of the road is placed this year at 150,000,000 passengers. The gross earnings of the company last year were $5.780,082.57. If the increase in passenger traffic anticipated be realized the gross earnings of the system this year ought to be $7,706,776.76. The journal cited states that this estimate is justified by the opinions of the best informed street railway men. An increase of capital stock of $16,400,000 is proposed.

The Official Reports of the Smokeless Powder Tests made last year at the Springfield Armory places the Maxim Smokeless Powder at the head of the list. This power appears not to be subject to deterioration by variation of temperature and effect of moisture. The grains are regular in shape and size, and the shell is easily loaded. When ignited in a train and in the open air it burns much slower than gunpowder, with no smoke and with but little flame. When fired from a gun it is also smokeless and fouls the gun very little. High and uniform velocity with moderate pressures were also obtained from this powder. It almost appears from this report that Mr. Maxim has, in this invention, made as important an advance as he did in his great invention of operating a gun through force derived from its recoil.

A Singular Steamboat is now being constructed by the Pusey and Jones Company, Wilmington, Delaware, for Mr. Pierre Lorillard, of New York City. It is appropriately called a *house boat* because it is in fact a house erected upon a scow boat, the hull being provided with triple expansion engines for its propulsion. The scow is 96 ft. long, 25½ ft. wide at the deck, and 20 ft. wide at the bottom, with overhung main-deck guards. The house occupies all the deck space except a narrow passage along each side and very small spaces fore and aft. The *American Shipbuilder* has

given an extended description of this curious boat from which we gather that the main deck is to be divided into machinery, storage room, pantry, kitchen and quarters for the crew. The hull will contain an ice-house. The owner's quarters are to be on the saloon deck. Here there will be a dining-room 17½ ft. long by 15½ ft. wide; a sitting-room; four bedrooms; 2 bath rooms and the toilet rooms. On the hurricane deck there is to be a pilot house and studio. The interior is to be highly decorated and the furniture for the living rooms is now being constructed in New York from special designs made for the vessel. The house will rise perpendicularly 14 ft. above the main deck. It is understood that the vessel is designed for the shallow waters of Florida. High speed is not expected, but the intention appears to be to supply, as far as possible in a navigable boat, all the comforts of a modern home.

A Big Undertaking is that which Mrs. Potter Palmer of Chicago, President of the Board of Lady Managers of the Columbian Exposition, has stated to be the intention of that board. It is the purpose to show to the fullest extent possible the great share that women have in the world's work. The board maintains that women have reached the point where they can afford to compete on equal terms with men. As a preliminary step in the work the board has undertaken, a request has been inserted in all blank applications for space that it shall be stated whether the article to be exhibited was produced wholly or in part by the work of women. If this question be answered in the affirmative the Board of Lady Managers becomes entitled by such answer to appoint members of the juries of award. Mrs. Potter Palmer has stated in a recent address that "the desire of the Lady Managers is to present a complete picture of the condition of women in every country of the world at this moment, and more particularly of those who are bread-winners." She further says that it is the aim of the managers "to show also the new avenues of employment that are constantly being opened to women and in which of these they are most successful by reason of their natural adaptability. It is hoped that by the efforts which the board will put forth the character of the education which will best fit women for the new opportunities awaiting them will be ascertained, and that answers to many other important questions relating to their welfare will be ascertained. Mrs. Palmer in the address cited speaks as follows:

"Our board proposes to enlarge upon the work of statisticians and make a thorough canvass in order to discover for itself the condition of women, and especially the amount of child-labor employed, the proportion of wages that women get for their share of the world's work; whether their taste and delicacy of touch are of discinct value in the labor of the world, and to verify the statistics of the labor bureau generally, and to see if, with the sympathetic discernment of women, we can discover any salient points which have never yet been made a matter of record."

To carry out these views and to obtain the co-operation of women throughout the world, petitions will be sent through American ministers to foreign governments, asking these governments to appoint bodies of women to co-operate with the board. In this way the women of foreign countries will gain a recognition never before given them by the State, and if their work is well done it is thought this precedent will secure their recognition in similar projects in their own countries.

The Announcement of the Completion of the Pacific Coast Survey is received. It was begun in 1871 by the Steamer *Hassler*, especially designed and constructed for this work, and which has been in the service ever since. Professor Agassiz accompanied her on her first trip, and made a systematic series of deep sea dredgings extending along the North and South American coasts, the results being of great scientific value. The recent surveys of the coast line of Southern California indicate that this coast is more abrupt than that of any other part of Northern America, the depth being 100 fathoms at a distance of a mile or less from the shore. This depth is only reached at distances of from 25 to 100 miles from the shore in other parts of the Atlantic and Pacific Oceans.

The St. Louis Fair, which annually attracts the attention of manufacturers in this country, will, it is said, be this year a grander affair than ever. There will be one hundred more exhibitors than have ever before been seen on the St. Louis Fair grounds. It is further said that applications for space are pouring in to such an extent that the management is very much perplexed to arrange for them. Very favorable arrangements have been made for the exhibition of farm machinery, implements and vehicles. A big field inside of the race track has been set apart for threshing outfits, feed mills and ensilage cutters; and the space which was formerly occupied by these exhibits will this year be reserved for threshing machines and traction engines. The now proverbial success of this annual fair is explained in a statement made by Mr. Alva Mansur, one of the directors, in a conversation with a newspaper correspondent. He is quoted as saying that the directors would rather lose money than see an exhibitor go away feeling that he has been disappointed.

The Recent Remarkable Trip made by the ocean steamer *Majestic*, in which she not only eclipsed all records of other vessels but her own previous record also, is attracting much attention to the rapid gains which are making in the speed of ocean steamers. It has recently been announced and noticed in this magazine that steamship builders upon the Clyde are credited with the intention of building a steamer which will be able to cross the Atlantic in five days. The builders of the *City of New York* and the *City of Paris* actually exhibited a model designed to attain this speed at the Naval Exhibition. Now it is also asserted that Mr. Carl Schurz, President of the Hamburg-American Packet Company, states it as his opinion that it is feasible to build a steamship which will cross the Atlantic in three days, his scheme being that the vessel should be made larger than the present steamers, arranged to carry passengers only, and supplied with two distinct sets of powerful machinery divided by a longitudinal bulkhead and driving twin screws, either set being of sufficient power to propel the vessel at the necessary velocity in case of accident to the other. While we do not share Mr. Schurz's opinion that a three days' trip with vessels propelled by steam is possible, we feel sure that the reduction of the time to five days has no practical obstacle except a commercial one. With engines as now constructed and of sufficient power, a steamship can be driven across the ocean in five days if coal enough be burned to do it. The question remains as to whether the speed thus attained would be profitable. A simple computation will show that only 13% reduction on the speed attained by the *Majestic* in her recent trip is necessary to accomplish this result.

Since the above was written the *Teutonic* has beaten all records, having made the voyage from Queenstown to Sandy Hook Lightship in 5 days, 16 hours and 31 minutes; making on the 5th day out the remarkable record of 517 knots, and beating the passage of the *Majestic* 1 hour and 37 minutes.

The Steam Launch, *Norwood*, has beaten the record for speed, having, on the 19th of August, made the run from the Narrows in New York Harbor to Sandy Hook about 14 miles, in the remarkable time of 32 minutes. It is asserted by those who saw the run from the fast steamer *Monmouth*, that for a part of the trip the *Norwood* made certainly not less than a mile in 30 seconds. The *Monmouth* is the fastest boat in the harbor, but the little launch was able to show her heels to the passenger steamer very quickly and to run completely out of sight before reaching Sandy Hook. This wonderful launch was designed by Mr. C. B. Mosher, a "Down-Easter," hitherto unknown to fame. When she was built her engines failed to work properly until overhauled by Mr. Reuben Riley of Brooklyn, New York. She has a length of 63 feet 2½ inches, a beam of 7 feet and a draft of 18 inches. Her engines are of the Thorneycroft Pattern and occupy a floor space of not more than 6 by 2 feet. The race was a very exciting one to the passengers on the *Monmouth*. The owner of this phenomenal launch is Mr. Norman L. Munro of New York, who

has successively been the owner of the *Henrietta* and the *Now Then*, both famous for their speed.

The Council of the Society of Arts has been appointed a royal commission for the purpose of superintending and directing the formation of the British Section at the Columbian Exposition. £25,000 sterling has been placed at the disposal of the Council for this purpose. The sum is considerably less than has been given for previous expositions, but it is stated that the willingness of the Council to accept a comparatively small sum is due to the experience gained at the Paris Exposition of 1889, when no grant at all was made by the Government, and the expenses of the British section were defrayed by the exhibitors themselves aided by contributions obtained by the Mansion House Committee. *Invention* (London), states that Sir. Henry Trueman Wood, Secretary of the Society of Arts, filled the office of Secretary to the British section on that occasion and the results obtained convinced him that the Government contribution will be supplemented to any necessary extent. It is also stated that the authorities at Chicago will allot space to the British Commission without charge, and that a certain rent will be paid by every exhibitor. The Council believes that this source of income alone will be sufficient to bring the £25,000 allotted to the full amount required for the expenditure of the Commission.

Mr. James Dredge, editor of *Engineering* (London), the foremost engineering periodical in England, is said to be taking a great personal interest in the exhibition of English mechanical progress at the World's Fair in Chicago. It is stated that he will shortly visit Chicago in the interests of such an exhibit, and with a view to get the work of the British Section properly started.

The Reduction of Patent Fees in the English Patent Office has had the result, as might naturally be expected, of largely increasing the business and the income of the office. The report of the Comptroller General of Patents for 1890 just issued shows the growth in the number of applications for patents, which has now reached the figure of 21,307. In the first year since the last change in the law—1884—the number sprang up from 5993 to 17,110, the highest figure, 6241, having been reached in 1882. In the following year the numbers fell a little, to 16,101; but in 1886 they increased again, and the increase has been steady down to the last year for which we have a record. The revenue of the office is very large, £192,606. Of this, £83,240 was expended, leaving a surplus for the year of £109,366. This surplus is not equal to that annually earned under the older system, the surplus income for the year 1883 amounting to £172,527, the total revenue for that year being £224,956. The diminished income is of course due to the lowered scale of fees. The patent fees in the English office are now under consideration, and a further reduction is likely to be made. The contrast between £7 sterling for 17 years' patent rights in the United States and of £154 for a patent lasting only 14 years in England has been brought to the attention of Sir Michael Hicks-Beach, and the assurance from him that the whole subject of patent fees will be taken into consideration with a view of lowering them has been obtained.

The Lofoden Cod Fisheries, according to the report of the British Consul-General at Christiania, has been this season more than ordinarily successful. The habits of the fish and the way in which they have been caught have differed entirely from those of last year. The fish appear to have kept near the surface of the water and traveled up the fiords. 31,000,000 fish have been caught as against 18,000,000 last year, and not only the number is greater but the prices have been higher. 27,400,000 of the catch have been prepared as split cod; 3,600,000 have been dried. A factory was erected for preparing pressed cod but was unfortunately destroyed by fire. The great bulk of the catch has been preserved. The weather conditions have prevented the shipment of the fish to distant places. 30,324 men have been engaged in the fishing. The average catch has been 1022 fish for each man, which is not considered unprecedented.

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ILLUSTRATED articles are indicated by an asterisk (*), continued articles by a dagger (†), and concluded articles by a double dagger (‡). Orders for copies of the publications mentioned should be sent direct to the addresses given.

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HOT WATER HEATING VERSUS STEAM HEATING.

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OF all substances known to man, water possesses the greatest number of properties which are important and remarkable both from a scientific and practical point of view. Invisibly suspended in the atmosphere or massed there in vapor, lying in large volume in oceans, lakes or rivers, and capping with ice the peaks of mountain ranges, it determines local climatic conditions more than aught else.

It was almost a matter of course in human progress, when it was fully comprehended that the force stored in the vapor of water is its contained heat, that the possibilities of the use of steam as a vehicle for the conveyance and application of heat should have dawned upon the minds of men.

As a means for heating buildings, it is superior to all appliances which preceded it, and its use for that purpose has been very extensive. We shall subsequently see that a still better method is slowly but surely supplanting it. For the present, let us briefly glance at the properties of this wonderful substance (no less wonderful because so common that they are scarcely thought of by any but engineers and physicists), properties which fit it for a carrier and distributor of heat.

Of these the most important is what is called by scientists its *latent* heat. The amount of heat required to change the temperature of a pound of water from 32° to 33° F., or *vice versa*, has been adopted as the unit of heat quantity, called "thermal unit"; and a change in a pound of liquid water one degree at any other temperature practically requires an increase or decrease of one thermal unit, except when water is forming into steam, or steam is condensing into water, in which cases a peculiar action may be detected by the employment of scientific methods and appliances. While the water is forming into steam at atmospheric pressure, each pound of it absorbs 966.5 thermal units; a thermometer whose bulb is immersed therein all the while registering a constant temperature of 212° F. An accounting can be rendered for the heat so disappearing, but an attempt to do this would lead into a discussion foreign to the purpose of this article. Suffice it to say that when the steam is again condensed, it is found that although the heat temporarily disappeared, it is restored again without loss. Thus one pound of steam at 212° F. when condensed, suffices to raise the temperature of 966.5 pounds of water one degree F. This wonderful transformation of heat into potential energy in steam, and the reconversion of this potential energy into heat without loss, will ever remain among the most marvellous of physical phenomena.

By virtue of the potential energy into which the disappearing heat is converted, the steam acquires the power of infinite expansion, unless this expansion be restrained by external pressure. When so restrained, and heat is still further imparted to it, the pressure increases.

It follows from these important properties of steam, that when confined in any space (as a system of heating apparatus consisting of one or more boilers, pipes and radiators), its expansive force tends to press it into the part of reduced pressure. This action is independent of gravity, and is the principle upon which the circulation of the steam depends in any steam heating system. For, in contact with the containing walls of radiators, or pipes, it imparts its contained heat to the metal, the latter emitting the heat so received to the air. This loss of heat from the steam causes its condensation to water, in an exact proportion to the heat so lost. If 966.5 thermal units pass out in this way,

one pound of the steam is reduced to water. This weight of steam at a pressure of five pounds per square inch above that of the atmosphere (about the average pressure employed in low pressure steam heating) occupies a volume of about 20 cubic feet, which, on condensation, would become a void (except for the very small volume of condensed water) were it not that condensation and diminution of pressure occur simultaneously, and pressure in other parts of the system fills the void. The pressure at parts where condensation is active is therefore always somewhat less than where it is less active, or where it does not occur. The expansive force in the latter therefore constantly pushes forward the steam into those parts where condensation takes place. The water of condensation either runs backward into the boiler, or, as in some cases is necessary, it is trapped out of the pipes and radiators.

RESIDENCE OF COL. DONN PIATT, MAC-O-CHEE, O.
Heated by the Hot Water System.

It has seemed necessary to make this somewhat technical exposition of the properties of steam for the benefit of unprofessional readers, because the amount of heat carried by a *pound* of steam, and the rapidity with which steam circulates through pipes are sometimes made to appear very important advantages as compared with the less heat carried by a *pound* of water and the slower circulation of the latter, effected solely by changes in specific gravity. We shall see, however, that there are drawbacks to the advantages of steam for house heating, inherent in the very properties which enable it to be so used, and which have been above enumerated and explained.

While by virtue of its latent heat it forms *in proportion to its weight* the most admirable carrier of heat known to science; and by reason of its expansibility its rapid circulation in any direction is easily effected, yet the very fact that it is *steam* imposes a rigid limit of temperature that unfortunately cannot be passed. It *can never be cooler than 212°* under ordinary atmospheric pressure, this pressure being a condition of all practical steam heating as applied to buildings. The necessity of *some* unbalanced pressure to secure circulation compels even a higher temperature than this, the temperature corresponding to the average low pressure maintained (5 lb. per square inch above that of the atmosphere) being almost exactly 228° F.

Time and again attempts have been made to reduce the temperature in radiators, by means of pressure-reducing valves, and regulating valves, but the fact that below 212° F. there can be no steam and circulation ceases has barred any useful progress in this direction.

The result is that the practical regulation of steam heat in buildings, especially where direct radiators are employed, is a thing impossible. You must have all or none. The nearest approach to such regulation is the miserable make-shift known as "air-binding," in which air admitted into a radiator is relied upon to partly fill it and thus keep the steam from heating some indefinite part of its surface.

This method, besides requiring much too frequent attention for convenience, is so uncertain in its effects as never to give satisfactory results. To operate, the steam radiator must have both inlet and outlet valves open, and the air confined in the radiator being heavier than steam, gravitates toward the outlet, through which it has the trick of furtively passing into other radiators in the system. In this way, unless frequently attended to, the attempt to regulate by air-binding (at the best always unreliable) will fail altogether.

RESIDENCE OF J. W. MCALLISTER, ESQ., ST. JOSEPH, MO.

Heated by the Hot Water System.

So in the cool nights of spring or autumn when only a gentle warmth is necessary to render a house comfortable, the occupants must either sit chilled and uncomfortable, or take the even greater risk of steaming in perspiration. Bad as this is, it is not all. The steam pressure must be maintained; and to do this, fuel must be consumed in vastly excessive quantity over the actual needs for heating. Thus, those who are rendered uncomfortable by excess of heat are compelled to pay an extravagant price for it, whereas, as will soon appear, by the use of hot water heating apparatus perfect comfort is attainable in moderate weather at one half the cost of discomfort.

Hot water heating was known to and practised by both the Egyptians and Romans before the Christian era. But they used it only for heating their baths. Since the introduction of iron pipes it has been constantly more or less practised for heating both water tanks and buildings. From a little before the middle of the present century (about the time *low pressure steam heating* was introduced) steam heating has greatly extended; but it has reached its limit. Hot water heating will henceforth take the lead, as meeting all conditions of safety, health, comfort and economy more fully than any other known system.

Within the last decade there has been a sudden and remarkable increase in the popularity of hot water heating, due to a combination of causes. There is a much larger proportion of our population possessed of means to purchase superior appliances than formerly. The extending taste for good solid reading, has largely increased the stock of general information upon subjects pertaining to sanitation, among which the heating and ventilating of homes occupy a most important place. But the inventive genius of this country in its supply of appliances for perfecting systems of hot water heating and adapting them to domestic use has been the chief factor in this change of opinion. An examination of the Patent Office Records shows an extraordinary amount of activity in this line of improvement.

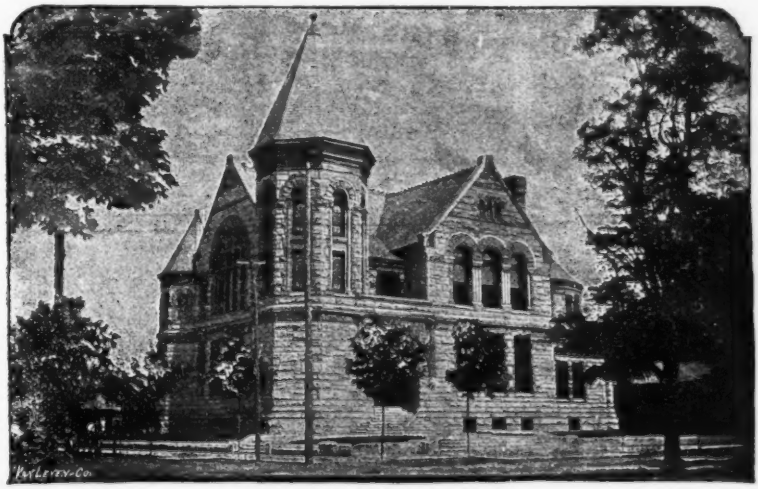
Among the numerous appliances thus produced the hot water boiler, as it is popularly called, is entitled to the first place as regards its importance. The name "boiler" is, however, a misnomer, as the water in a good hot water heating apparatus is rarely or never heated to the boiling

point. "Hot water heater" is a name more consonant with the facts, but its tautological sound has probably led to a too common use of the more euphonious, though less accurate term.

The functions of a hot water heater are to supply heat to its contained water, to be conveyed to coils or radiators at a distance from it, and also to produce in the water the necessary motion for the transmission of the heat. The heat thus brought to the radiators is diffused from them in the same ways as from steam radiators,—by contact of air and by radiation.

Now, while a pound of steam in condensing to water can give off 966.5 thermal units, and a pound of water in cooling from 180° to 70° can give off only 110 thermal units, it has been shown above that a pound of steam as ordinarily used for steam heating occupies a space of 20 cubic feet, or a space that would hold over 1200 lbs. of water heated to 180° F. A simple multiplication shows this volume of water to contain over 130,000 available units as compared with 966.5 units in the steam filling the same space. It forms therefore a storehouse for heat to which steam is in no way comparable, and the velocity of its circulation may be immensely lower than steam and yet it is able to convey all and more heat than the radiators can extract from it. Hence it is that while the temperature of a room heated by steam falls rapidly whenever the fire in the boiler gets low, the water continues its action for a long time without any perceptible diminution. The sudden and violent fluctuations to which temperatures produced by steam heating are liable are unknown in hot-water heating. This is its crowning advantage. Uniform heating of buildings worthy the name "uniform" has never been reached by any other means.

But there is this important and fundamental distinction between the action of a steam coil or radiator and one which takes its heat from hot water, that whereas, as has been already shown, the former can only operate *at temperatures of 212° F. and upwards, the latter can operate at any temperature whatever that is higher than that of the air surrounding it.* Thus if air at 60° F. envelopes the radiator and the apparatus is adjusted to heat water to 180° F. as its maximum, there is a range of 120° F., all through which the hot water radiator can work, and this range is perfectly controllable. In mild weather just the heat needed can be supplied and no more. As the weather gets colder the



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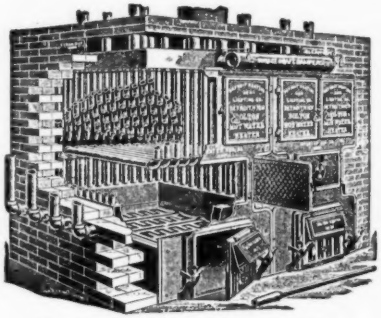
Containing 225,000 cubic feet. Heated by the Hot Water System.

heating can be increased to meet the exact requirements. Compare this with a low pressure steam apparatus adjusted to carry steam at 228° F. as its maximum. It cannot work below 212° F., hence the difference between this and the maximum temperature, or 16° F., is the range through which any variation is possible. The hot-water heating apparatus is therefore adapted to all climatic conditions, while the steam-heating radiators, if proportioned to the demand for extreme cold weather, *are and must remain too powerful* for any weather much warmer than the extreme. For mild weather, when the steam heat becomes unbearable, the remedy is to open the windows and waste heat by these avenues to interstellar space, or to shut off the radiators and send the waste heat out of the chimney, while the room cools down. In steam-heating a condition of health and comfort is exactly reversed. The range of temperature variation which should be confined to the heating apparatus alone, is transferred to the apartments, which are now too cold and anon too warm, instead of being heated to a uniformly pleasant and wholesome temperature.



A TYPE OF HOT WATER HEATER.—THE BOLTON.

A very large family of hot-water heaters has grown up in this country, but as is usual in large families comparatively few have achieved marked success in commercial life. The most of them have sunk into obscurity, or, at best, have only attained to a respectable mediocrity. This is due either to ignorance of fundamental principles on the part of their inventors or to an improper application of these principles.

A common fault in many such heaters designed for domestic use is that they require too large a mass of water to be heated and are thus too slow in their action. Another common fault is that the heating surface in them is much too small, in proportion to their grate surface and the amount of heating they are intended to perform. When this is the case there is an unavoidable constant waste of heat from the chimney, which increases to a maximum when the heater is called upon to perform its full duty.

How to gain this surface without rendering a heater extravagantly expensive, at the same time so presenting it to the glowing furnace fire as to secure the best effect from the radiant heat of the incandescent fuel and the contact of the heated gases, while the circulation of the water in the interior retains the utmost freedom, has been a problem that has severely taxed inventive skill.

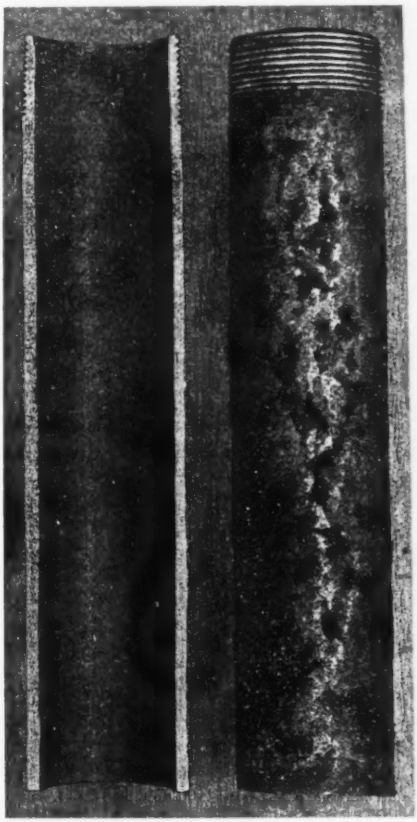
A fault of a great many hot-water heaters is their high resistance to circulation. As gravity acts vertically, only in the vertical parts of a heater can force be generated to create and maintain circulation. All circulation in horizontal spaces is at the expense of force generated in vertical parts, and it can easily be seen from this, that the larger the proportion of horizontal, as compared with vertical space in a boiler, the greater will be its resistance to circulation.

A water tube construction early claimed the attention of inventors, but its practical application to hot-water heaters presented many difficulties. Effects of expansion, a proper relation of position between the surface and the furnace grate; proper proportion of the surface area of tubes to the grate; circulation of water in the interior; cheapness in manufacture; ease of erection; durability in service; ease of management by users; tightness of joints and other practical considerations, all enter into this problem, complicating it to such an extent that only quite recently has a solution been reached without a compromise of one or more—generally more—

of these conditions, all essential to a perfect construction.

The solution has, at last. been attained through the adoption of what is known as the "*Drop-Tube* system."

What is a "drop-tube"? It is a metal tube connected by its upper extremity to a metallic shell and extending downward toward the furnace grate into the heated gases of combustion. The lower end of this tube is closed by welding; and in its interior is placed concentrically a smaller tube open a both ends, and extending downward toward, but not entirely to the bottom of the outer tube. This divides the interior space into two spaces — a central cylindrical space, and an annular space surrounding it. In such a tube, when the exterior is heated and the upper shell is filled with water, the circulation is so powerful that it is impossible to overheat the tube. The water in the annular space is heated and rises while cooler water flows down through the inner tube to replace it. The action is perfect even in tubes of small diameter, and it has been found that even 1-inch tubes leave nothing to be desired as regards circulation. The lower ends of the tubes in the drop-tube system being free, expansion and contraction exert no strain upon their connections, and, by their use, any desired amount of heating surface in proportion to grate surface can be obtained. In short, the use of these drop-tubes overcomes all the difficulties above enumerated that have hitherto precluded the construction of hot water heaters in strict accordance with all sound scientific and mechanical principles.



SECTION AND ELEVATION OF TUBES AFTER MANY YEARS SERVICE.

There can be no question that, the even, and comparatively thin wrought-iron tubes are superior to the thicker, heavier and uneven cast-iron sections used in many hot water heaters. The dividing up of the water into small spaces, enabling the fire to come in contact with it in the most direct and extensive way is a feature of the drop-tube system to which, doubtless, much of its efficiency is due.

The drop-tube system for steam boilers preceded its application to hot water heaters, and practice has shown the great durability of this construction. The circulation is so active that deposits of sediment do not clog the tubes. Mr. J. L. Miller, an engineer at Oberlin, Ohio, has publicly stated under date of May 11, of the present year, that in a steam fire-engine drop-tube boiler of which he had the supervision seven and one-half years prior to the date of his statement, and from which the water had not been drawn off for a period of thirteen years, he drew the water out of eighteen of the tubes into a clean pail and found not half a gill of sediment in the whole of them. This, notwithstanding the boiler had been supplied with surface water from street reservoirs.

Photographs of old tubes taken from these boilers after many years of severe use and sawn asunder longitudinally, show them not only free from deposits, but clean and practically as good as new. The cuts show the tubes exactly as they appeared after sawing them open. Engineers, perhaps more than laymen, will appreciate the significance of these cuts in which the sharpness of the screw-threads, and the unchanged regular thickness of the tubes are points that will immediately arrest attention, showing that the tubes were when taken out, good for at least fifteen years further service.

The rapid and great success of this system applied to hot water heaters has done much to increase the popularity of hot-water heating, more particularly in the regions of cold winters in Canada and the Northern States where a great number of large and important public buildings have been heated by it. A long list of elegant private mansions, in the number as well as in the character of the buildings comprised in it, gives most emphatic testimony as to its merits. The cut sufficiently displays the simple details of this hot water heater without a special technical description. It is known throughout the country as the "Bolton Hot Water Heater," and is manufactured solely by the Detroit Heating and Lighting Co. The commercial success achieved is not due alone to the commercial ability of its manufacturers. Permanent success cannot be thus attained in an apparatus of this kind. Intrinsic merit is the only basis upon which can be reared a hot-water heating business so extensive as has grown up from this simple but scientific invention. The well-known integrity of the manufacturers in making good all their guarantees, and their exact business methods, though necessary to commercial success, could never have reached the results attained with this heater, had they been handicapped with any inferiority in the heater itself.

This firm has published an interesting, instructive, and beautifully illustrated treatise entitled "WARMTH FOR WINTER HOMES," which any one may get on application to the manufacturers at their home office, Detroit, Mich., or at any of their branches in the leading cities. It gives full details of the construction of the heater, lists of public and private buildings heated with it, and full information for those seeking the best means and methods for producing a healthful atmosphere in dwellings.

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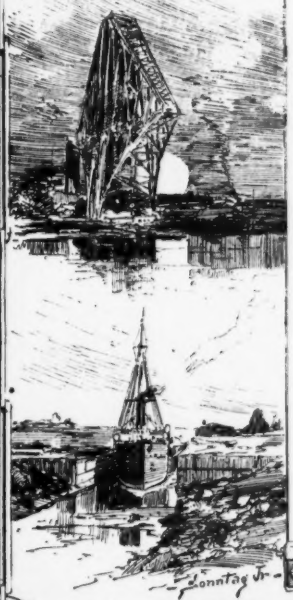

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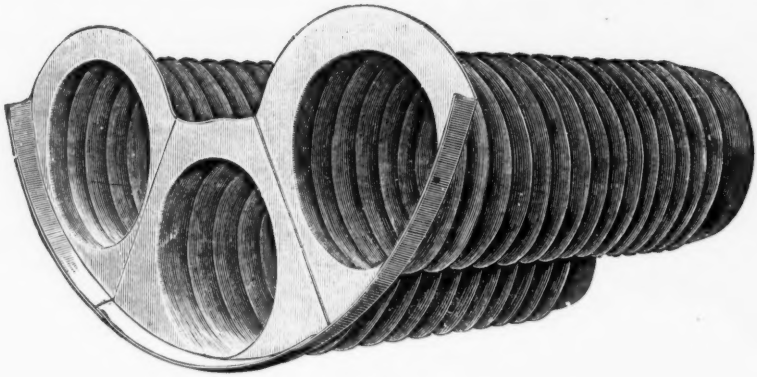

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P. L. Sword & Son, Cleveland, O.

Cables, Wire.

Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
John A. Roeblings Sons Co., Trenton, N. J.
Trenton Iron Co., Trenton N. J.
Washburn & Moen Mfg. Co., Worcester, Mass.

Cables, Electric and Submarine.

Bishop Gutta Percha Co., 420 to 426 E. 25th St. N. Y.
New York Insulated Wire Co., 649-651 B'dway, N. Y.
The International Okonite Co., 13 Park Row, N. Y.

Calipers and Dividers.

F. W. Devoe & Co., 101 Fulton St., N. Y.

Calculators.

R. C. Smith, 1 Broadway, N. Y.

Cars, Railroad.

New York Equipment Co., 15 Wall St., N. Y.

Cars, Street Railway.

John Stephenson Co., Limited, New York.

Carpenters' Tools.

Stanley Rule & Level Co., New Britain, Conn.

Car Wheels.

New York Equipment Co., 15 Wall st., N. Y.

Castings, Iron and Steel.

Audubon Machine Works, New Haven, Conn.
Chester Steel Castings Co., Phila., Pa.

Chains.

Washburn & Moen Mfg. Co., Worcester, Mass.

Chain Belting.

Jeffrey Mfg. Co., Cleveland, O.

Chemists.

Francis Wyatt, 12 Park Place, N. Y.
Gideon E. Moore., 221 Pearl St., N. Y.

Chucks

The E. Horton & Son Co., Windsor Locks, Conn.

Clutches, Friction.

The D. Frisbie Co., 108 Liberty St., N. Y.

Coal Mining Machinery.

Beckett Foundry & Machine Co., Arlington, N. J.
Edison General Electric Co., 68 Broad St., N. Y.
C. W. Hunt Co., 45 Broadway, N. Y.

Ingersoll-Sergeant Rock Drill Co,, 10 Park Pl., N.Y.
Jeffrey Mfg. Co., Columbus, Ohio.

Coal Handling Machinery.

Brown Hoisting & Conveying Co., Cleveland, Ohio.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.

Colliery Plant.

Edison General Electric Co., 68 Broad St., N. Y.
C. W. Hunt Co., 45 Broadway, N. Y.
Ingersoll-Sergeant Rock Drill Co., 10 Park Pl., N. Y.
Jeffrey Mfg Co., Columbus, Ohio.

Concentrators and Pulverizers.

Frisbee-Lucop Mill Co., 145 Broadway, N. Y.
S. R. Krom, 151 Cedar st., N. Y.
Sturtevant Mill Co., Boston, Mass.
Copeland & Bacon, 85 Liberty st., N. Y.

Consulting Engineers.

Leicester Allen, World Building, N. Y.
Thomas C. Clarke, 1 Broadway, N. Y.
T. G. Gribble, 76 Broad St., N. Y.
E. E. Olcott, 18 Broadway, N. Y.
Rafter & Dodgson, Rochester, N. Y.
Horace See, 1 Broadway, N. Y.

Construction Companies.

Berlin Iron Bridge Co., East Berlin, Conn.

Contractors' Supplies.

Bucyrus Steam Shovel and Dredge Co., Bucyrus, O.
Copeland & Bacon, 85 Liberty St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
Grant McNeil, 240 N. Union St., Akron, Ohio.
J. S. Mundy, Newark, N. J.
John Souther & Co., Boston, Mass.

Corrugated Boiler Furnaces.

Continental Iron Works, Brooklyn, N. Y.

Cotton Presses.

Boomer & Boschert Press Co., Syracuse, N. Y.

Corrugated Iron.

Merchant & Co., Phila., Pa.
Thompson Mfg. Co., Cleveland, O.

Conveying Machinery.

Brown Hoisting and Conveying Co., Cleveland, O.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, O.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.

Cranes.

Copeland & Bacon, 85 Liberty st., N. Y.
Farrel Foundry and Machine Works, Ansonia.
Southwark Foundry and Machine Co., Phila., Pa.
Yale & Town Mfg. Co., Stamford, Conn.

Crushers, Ore and Rock.

Beckett Foundry and Machine Co., Arlington, N. J.
Copeland & Bacon, 85 Liberty St., N. Y.
Farrel Foundry and Machine Co, Ansonia, Conn.
Frisbee-Lucop Mill Co., 145 Broadway, N. Y.
S. R. Krom, 151 Cedar St., N. Y.
Sturtevant Mill Co., Boston, Mass.

Damper Regulators.

Mason Regulator Co., Boston, Mass.

Desks.

Wm. Schwarzwaelder & Co., 37-39 Fulton St., N. Y.

Diamond Drills.

American Diamond Rock Boring Co., 15 Cortlandt St., N. Y.
Ingersoll-Sergeant Rock Drill Co., 10 Park Pl., N.Y.

Dies.

E. W. Bliss Co., Limited, Brooklyn, N. Y.
Miner & Peck Mfg. Co., New Haven, Conn.

Drawings, Mechanical.

Audubon Machine Works, New Haven, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.

Drawing Materials.

F. W. Devoe & Co., 101 Fulton St., N. Y.

Dredging Machines.

Bucyrus Steam Shovel and Dredge Co., Bucyrus, O.

Drilling Machines.

Brown & Sharpe Mfg. Co., Providence, R. I.

Drills, Rock.

American Diamond Rock Boring Co., 15 Cortlandt St., N. Y.
Edison General Electric Co., 68 Broad St., N. Y.
Ingersoll-Sergeant Rock Drill Co., 10 Park Pl., N.Y.

Drills, Iron and Wood.

Brown & Sharpe Mfg. Co., Providence, R. I.
The E. Horton & Son Co., Windsor Locks, Conn.

Drop Forgings.

Audubon Machine Works, New Haven, Conn.
Miner & Peck Mfg. Co., New Haven, Conn.

Drop Presses.

E. W. Bliss Co., Limited, Brooklyn, N. Y.
Miner & Peck Mfg. Co., New Haven, Conn.
Stiles & Parker Press Co., Middletown, Conn.

Drop Hammers.

E. W. Bliss Co., Limited, Brooklyn, N. Y.
Miner & Peck Mfg. Co., Brooklyn, N. Y.
Stiles & Parker Press Co., Middletown, Conn.

Dumping Barrows.

Grant McNeil. 240 N. Union St., Akron, Ohio.

Dynamite.

Ingersoll-Sergeant Rock Drill Co., 10 Park Pl., N. Y

Dynamos, Electric.

Audubon Machine Works, New Haven, Conn,
Crocker-Wheeler Co., 430 West 14th St., N. Y.
"C. & C." Electric Motor Co., 402 and 404 Greenwich St., N. Y.
Edison General Electric Co., 68 Broad St., N. Y.

Electrical Instruments.

Audubon Machine Works, New Haven, Conn.
Weston Electrical Instrument Co., Newark, N. J.

Electric Rock Drills.

Edison General Electric Co., 68 Broad St., N. Y.

Electrical Rubber Goods.

B. F. Goodrich Co., Akron, Ohio.
Home Rubber Co., Trenton, N. J.
N. Y. Belting and Packing Co., 13 Park Row, N. Y.

Electrical Machinery.

Audubon Machine Works, New Haven, Conn.
Edison General Electric Co., 68 Broad St., N. Y.
The Crocker-Wheeler Co., 430-432 W. 14th St., N. Y.
Weston Electrical Instrument Co., Newark, N. J.

Electric Lighting Plant.

Edison General Electric Co , 68 Broad St., N. Y.

Electric Motors.

Audubon Machine Works, New Haven, Conn.
The Crocker-Wheeler Co., 430-432 W. 14th St., N. Y.
"C. & C." Electric Motor Co., 402-404 Greenwich St., N. Y.
Edison General Electric Co., 68 Broad St., N. Y.

Elevators, Electric.

The D. Frisbie Co., 108 Liberty St., N. Y.
Otis Elevator Co., 38 Park Row, N. Y.

Elevators, Steam and Hydraulic.

The D. Frisbie Co., 108 Liberty St., N. Y.
Otis Elevator Co., 38 Park Row, N. Y.

Emery Mill Stones.

Sturtevant Mill Co., Boston, Mass.

Emery Wheels.

N. Y. Belting and Packing Co., 13 Park Row, N. Y.
Springfield Emery Wheel Mfg. Co., Bridgeport, Conn.

Emery Wheel Machinery.

Springfield Emery Wheel Mfg. Co., Bridgeport, Conn.

Engineers and Contractors.

Field Engineering Co., Central Building N. Y.
Gordon, Strobel & Laureau, Philadelphia, Pa.

Engines, Blowing.

Edw. P. Allis Co., Milwaukee, Wis.
Southwark Foundry and Machine Co., Phila., Pa.

Engines, Hoisting.

Edw. P. Allis Co., Milwaukee, Wis.
Beckett Foundry and Machine Co., Arlington, N. J
Copeland & Bacon, 85 Liberty St., N. Y.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
J. S. Mundy, Newark, N. J.

Engines, Marine.

The Atlantic Works, East Boston, Mass.

Engines, Pumping.

Edw. P. Allis Co., Milwaukee, Wis.
A. S. Cameron Steam Pump Works, E. 23d St., N.Y.
M. T. Davidson, Brooklyn, N. Y.
Deane Steam Pump Co., Holyoke, Mass.
Holly Mfg. Co., Lockport, N. Y.
Norman Hubbard, Brooklyn, N. Y.
Niagara Steam Pump Works, Brooklyn, N. Y.

Engines, Stationary.

Edw. P. Allis Co., Milwaukee, Wis.
Beckett Foundry and Machine Co., Arlington, N. J.
Fishkill Landing Machine Co., Fishkill, N. Y.
W. A. Harris Steam-Engine Co., Providence, R. I.
Philadelphia Engineering Co., Philadelphia, Pa.
Russell & Co., Massillon, Ohio.
Southwark Foundry and Machine Co., Phila., Pa.

Engines, Traction.

Edw. P. Allis Co., Milwaukee, Wis.

Engineers, Civil.

Thomas C. Clarke, 1 Broadway, N. Y.
T. G. Gribble, 76 Broad St , N. Y.
Rafter & Dodgson, Rochester, N. Y.
Samuel Webber, Charlestown, N. H.

Engineers, Mechanical.

Leicester Allen, World Building, N. Y.
Robert Grimshaw, 21 Park Row, N. Y.
Horace See, 1 Broadway, N. Y.

Engineers, Mining.

E. E. Olcott, 18 Broadway, N. Y.
Samuel Webber, Charlestown, N. H.

Engineering Instruments.

F. W. Devoe & Co., 101 Fulton St., N. Y.
Young & Sons, Philadelphia, Pa.

Engravers.

Moss Engraving Co., 585 Pearl St., N. Y.
Photo-Type Co., 76 Beekman St., N. Y.

Excavators.

Bucyrus Steam Shovel and Dredge Co., Bucyrus, O.
John Souther & Co., Boston, Mass.

Experimental Machinery.

Audubon Machine Works, New Haven, Conn.
Brown & Sharpe, Mfg. Co., Providence, R. I.
Edred W. Clark, Hartford, Conn.

Fire Felt.

H. W. Johns Mfg. Co., 87 Maiden Lane, N. Y.

Fans, Ventilating.

Audubon Machine Works, New Haven, Conn.
Barney Ventilating Fan Co., Providence, R. I.

Feed-Water Heaters.

Edw. P. Allis Co., Milwaukee, Wis.
Goubert Mfg. Co., 32 Cortlandt St., N. Y.

Fencing Wire.

Washburn & Moen Mfg. Co., Worcester, Mass.

Fire Extinguishers.

Grinnell Aut. Sprinkler Co., Providence, R. I.

Forgings.

Audubon Machine Works, New Haven, Conn.

Freight Cars.

New York Equipment Co., 15 Wall St., N. Y.

Furnace Builders.

Gordon, Strobel & Laureau, Philadelphia, Pa.

Furnaces, Corrugated.

Continental Iron Works, Brooklyn, N. Y.

Gauges, Steam.

Crosby Steam Gage and Valve Co., Boston, Mass.

Gear Cutters.

Brown & Sharpe Mfg. Co., Providence, R. I.
E. Horton's Sons Co., Windsor Locks, Conn.

Grinding and Polishing Machinery.

Springfield Emery Wheel Mfg. Co., Bridgeport, Conn.

Hammers, Power.

Hackney Hammer Co., Cleveland, Ohio.

Hardware Manufacturers.

Stanley Rule and Level Co., New Britain, Conn.
Yale & Towne Mfg. Co., Stamford, Conn.

Heaters, Steam and Hot Water.

Boynton Furnace Co., 207-209 Water St. N. Y.
Detroit Heating and Lighting Co., Detroit, Mich.
Gorton & Lidgerwood Co., 96 Liberty St., N. Y.
Hopson & Chapin Mfg. Co., New London, Conn.
National Hot Water Heater Co., Boston, Mass.
W. C. Mowry, Norwich, Conn.

Hoisting Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Beckett Foundry and Machine Co., Arlington, N. J.
Brown Hoisting and Conveying Co., Cleveland, Ohio.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Copeland & Bacon, 85 Liberty St., N. Y.
C. W. Hunt Co., 45 Broadway, N. Y.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
J. S. Mundy, Newark, N. J.
Trenton Iron Co., Trenton, N. J.

Hose, Steam and Fire.

Commonwealth Rubber Co., 9 Murray St., N. Y.
B. F. Goodrich Co., Akron, Ohio.
Home Rubber Co., Trenton, N. J.
N. Y. Belting & Packing Co., 13 Park Row, N. Y.

Hot Water Heating.

Boynton Furnace Co., 207-209 Water St., N. Y.
Detroit Heating and Lighting Co., Detroit, Mich.
Gorton & Lidgerwood Co., 96 Liberty St., N. Y.

Hopson & Chapin Mfg. Co., New London, Conn.
W. C. Mowry, Norwich, Conn.
National Hot Water Heater Co., Boston, Mass.

Hydraulic Machinery.

Boomer & Boschert Press Co., Syracuse, N. Y.

Incandescent Electric Lamps.

Edison General Electric Co., 68 Broad St., N. Y.

Indicators, Steam-Engine.

Crosby Steam Gage and Valve Co., Boston, Mass.

India Rubber Goods.

Commonwealth Rubber Co., 9 Murray St., N. Y.
B. F. Goodrich Co., Akron, Ohio.
Home Rubber Co., Trenton, N. J.
N. Y. Belting and Packing Co., 13 Park Row, N. Y.

Industrial Railways.

C. W. Hunt Co., 45 Broadway, N. Y.

Insulated Wire.

Bishop Gutta Percha Co., 420 426 East 25th St., N. Y.
New York Insulated Wire Co., 649-651 B'dway, N. Y.
The Int. Okonite Co,. Limited, 13 Park Row, N. Y.

Iron Buildings.

Berlin Iron Bridge Co., East Berlin, Conn.

Iron Importers.

Wm. Jessop & Sons, 91 John St., N. Y.

Iron and Steel.

Wm. Jessop & Sons, 91 John St., N. Y.

Iron Working Machinery.

E. W. Bliss Co., Limited, Brooklyn, N. Y.
Brown & Sharpe Mfg. Co., Providence, R. I.
E. Horton's Sons Co., Windsor Locks, Conn.
Long & Allstatter Co., Hamilton, Ohio.
Miner & Peck Mfg. Co., New Haven, Conn.

Joists, Iron and Steel.

Berlin Iron Bridge Co., East Berlin, Conn.

Launches and Yachts.

The Atlantic Works, East Boston, Mass.

Lifts

The D. Frisbie Co., 108 Liberty St., N. Y.
Otis Elevator Co., 38 Park Row, N. Y.

Locks and Knobs.

Yale & Towne Mfg. Co., Stamford. Conn.

Locomotives.

New York Equipment Co , 15 Wall St., N. Y.

Lubricants.

Jos. Dixon Crucible Co., Jersey City, N. J.

Machine Tools.

Brown & Sharpe Mfg. Co., Providence, R. I.
The E. Horton & Son Co., Windsor Locks, Conn.
Long & Allstatter Co., Hamilton, Ohio.

Machinery, Special.

Audubon Machine Works, New Haven, Conn.
E. W. Bliss Co., Limited, Brooklyn, N. Y.
Brown & Sharpe Mfg. Co., Providence, R. I.
Edred W. Clarke, Hartford, Conn.

Machinists Tools and Supplies.

Brown & Sharpe Mfg. Co., Providence, R. I.
The E. Horton & Son Co., Windsor Locks, Conn.
Long & Allstatter Co., Hamilton, Ohio.
R. C. Smith, 1 Broadway, N. Y.

Mats, Rubber.

Commonwealth Rubber Co., 9 Murray St., N. Y.
B. F. Goodrich Co., Akron, Ohio.
Home Rubber Co., Trenton, N. J.
N. Y. Belting and Packing Co., 13 Park Row, N. Y.

Mathematical Instruments.

F. W. Devoe & Co., 101 Fulton St., N. Y.
Richards & Co., Limited, 41 Barclay St., N. Y.
R. C. Smith, 1 Broadway, N. Y.
Young & Sons, Philadelphia, Pa.

Merchant Steel.

Chester Steel Castings Co., Phila., Pa.
Wm. Jessop & Sons, Limited, 91 John St., N. Y.

Meters, Water.

Deane Steam Pump Co., Holyoke, Mass.
Henry R. Worthington, 86-88 Liberty St., N. Y.

Mill Stones.

Sturtevant Mill Co., Boston, Mass.

Milling Machinery.

Beckett Foundry and Machine Co., Arlington, N J.
E. W. Bliss Co., Limited, Brooklyn, N. Y.
Brown & Sharpe Mfg. Co., Providence, R. I.
Long & Allstatter Co., Hamilton, Ohio.

Mining Screens.

Beckett Foundry and Machine Co., Arlington, N J.
Copeland & Bacon, 85 Liberty St., N. Y.
Harrington & King Perf. Co., Chicago, Ill.

Mining Machinery.

Beckett Foundry and Machine Co., Arlington, N. J.
Copeland & Bacon, 85 Liberty St., N. Y.
Cook Mining Machinery Co., Philadelphia, Pa.
Edison General Electric Co., 68 Broad St., N. Y.
Frisbee-Lucop Mill Co., 145 Broadway, N. Y.
Harrington & King Perf. Co., Chicago, Ill.
Ingersoll-Sergeant Rock Drill Co., 10 Park Pl., N.Y.
Jeffery Mfg. Co., Columbus, Ohio.
S. R. Krom, 151 Cedar St., N. Y.
Norman Hubbard, Brooklyn, N. Y.
Sturtevant Mill Co., Boston, Mass.
Trenton Iron Co., Trenton, N. J.

Model Makers.

Audubon Machine Works, New Haven, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Edred W. Clarke, Hartford, Conn.

Motors, Electric.

Audubon Machine Works, New Haven, Conn.
The Crocker-Wheeler Co., 430-432 W. 14th St., N. Y.
Edison General Electric Co. 68 Broad St., N. Y.

Motors, Water.

Pelton Water Wheel Co., San Francisco, Cal.

Office Furniture.

Wm. Schwarzwaelder & Co., 37-39 Fulton St., N. Y.

Ore Crushers.

Copeland & Bacon, 85 Liberty St., N. Y.
Frisbee-Lucop Mill Co., 145 Broadway, N. Y.
S. R. Krom, 151 Cedar St., N. Y.
Sturtevant Mill Co., Boston, Mass.

Ore Handling Machinery.

Brown Hoisting & Conveying Co., Cleveland, Ohio.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.

Packing.

H. C. Canfield, Bridgeport Conn.
Commonwealth Rubber Co., 9 Murray St., N. Y.
B. F. Goodrich Co., Akron, Ohio.
Home Rubber Co., Trenton, N. J.
N. Y. Belting and Packing Co., 13 Park Row, N. Y.

Paints.

F. W. Devoe & Co., 101 Fulton St., N. Y.
Joseph Dixon Crucible Co., Jersey City, N. J.

Gutta Percha Paint Co,, Providence, R. I.
H. W. Johns Mfg. Co., 87 Maiden Lane, N. Y.

Paper, Drawing and Tracing.

F. W. Devoe & Co., 101 Fulton St., N. Y.

Paper Mill Machinery.

Boomer & Boschert Press Co., Syracuse, N. Y.
Dayton Globe Iron Works, Dayton, Ohio.

Patent Machinery.

Audubon Machine Works, New Haven, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Edred W. Clark, Hartford, Conn.

Patterns.

Audubon Machine Works, New Haven, Conn.

Perforated Metal.

Harrington & King Perf. Co., Chicago, Ill.

Pile Drivers.

Bucyrus Steam Shovel and Dredge Co., Bucyrus, O.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.

Pipe Coverings.

H. W. Johns Mfg. Co., 87 Maiden Lane, N. Y.

Pipe-Spiral Riveted.

Abendroth & Root Mfg. Co., 28 Cliff St., N. Y.

Planes, Carpenters.

Stanley Rule and Level Co., New Britain, Conn.

Portable Railways.

C. W. Hunt Co., 45 Broadway, N. Y.

Power Hammers.

Hackney Hammer Co., Cleveland, Ohio.

Power Punches and Shears.

E. W. Bliss Co., Limited, Brooklyn, N. Y.
Long & Allstatter Co., Hamilton, Ohio.

Powder.

Ingersoll-Sergeant Rock Drill Co., 10 Park Pl., N. Y.

Presses, Dies, Etc.

E. W. Bliss Co., Limited, Brooklyn, N. Y.
Miner & Peck Mfg. Co., New Haven, Conn.
Stiles & Parker Press Co., Middletown, Conn.

Presses, Power.

Boomer & Boschert Press Co., Syracuse, N. Y.

Presses, Hydraulic.

Boomer & Boschert Press Co., Syracuse, N. Y.

Pressure Regulators.

Mason Regulator Co., Boston, Mass.

Propellers.

The Atlantic Works, East Boston, Mass.

Pulleys, Shafting and Hangers.

Dayton Globe Iron Works, Dayton, Ohio.
The D. Frisbee Co., 108 Liberty St., N. Y.

Pulverizers.

Frisbee-Lucop Mill Co., 145 Broadway, N. Y.
Sturtevant Mill Co., Boston, Mass.

Pumps and Pumping Machinery.

Edw. P. Allis Co., Milwaukee, Wiss.
A. S. Cameron Steam Pump Works, E. 23d St., N.Y.
M. T. Davidson, Brooklyn, N. Y.
Deane Steam Pump Co., Holyoke, Mass.
Holly Mfg. Co., Lockport, N. Y.
Niagara Steam Pump Works, Brooklyn, N. Y.
Norman Hubbard, Brooklyn, N. Y.

Punches and Shears, Power.

E. W. Bliss Co., Limited, Brooklyn, N. Y.
Long & Allstatter Co., Hamilton, Ohio.

Rails.

New York Equipment Co., 15 Wall St., N. Y.

Railway Supplies.

New York Equipment Co., 15 Wall St., N. Y.

Railroad Equipment.

New York Equipment Co., 15 Wall St., N. Y.

Railways, Portable.

C. W. Hunt Co., 45 Broadway, N. Y.

Reducing Valves.

Mason Regulator Co., Boston, Mass.

Revolvers.

Smith & Wesson, Springfield, Mass.

Road-Making Machinery.

Bucyrus Steam Shovel and Dredge Co., Bucyrus, O.
John Souther & Co., Boston, Mass.

Rock Breakers.

Copeland & Bacon, 85 Liberty St., N. Y.
Farrel Foundry and Machine Co., Ansonia, Conn
S. R. Krom, 151 Cedar St., N. Y.
Sturtevant Mill Co., Boston, Mass.

Rock Drills.

American Diamond Rock Boring Co., 15 Cortlandt St., N. Y.
Ingersoll-Sergeant Rock Drill Co., 10 Park Pl., N. Y.

Rolling Mill Machinery.

E. W. Bliss Co., Limited, Brooklyn, N. Y.
Long & Allstatter Co., Hamilton, Ohio.

Rolling Stock, Second Hand.

New York Equipment Co., 15 Wall St., N. Y.

Roofing.

Merchant & Co., Philadelphia, Pa.
Thompson Mfg. Co., Cleveland, Ohio.

Rubber Belting.

Commonwealth Rubber Co., 9 Murray St., N. Y.
B. F. Goodrich Co., Akron, Ohio.
Home Rubber Co., Trenton, N. J.
N. Y. Belting and Packing Co., 13 Park Row, N. Y.

Rules.

Stanley Rule and Level Co., New Britain, Conn.

Safety Valves.

Crosby Steam Gage and Valve Co., Boston, Mass.

Screw Propeller Blades.

The Atlantic Works, East Boston, Mass.

Screens, Mining.

Beckett Foundry and Machine Co., Arlington, N. J.
Harrington & King Perf. Co., Chicago, Ill.
S. R. Krom, 151 Cedar St., N. Y.

Second-Hand Rolling Stock.

New York Equipment Co., 15 Wall St., N. Y.

Separators, Coal and Ore.

Harrington & King Perf. Co., Chicago, Ill.

Separators, Steam.

The Stratton Separator Co., 32 Cortlandt St., N. Y.

Shafting.

Dayton Globe Iron Works, Dayton, Ohio.

Shears, Gate.

Long & Allstatter Co., Hamilton, Ohio.

Ship Builders.

The Atlantic Works, East Boston, Mass.

Springs.

Washburn & Moen Mfg. Co., Worcester, Mass.

Sprinklers, Fire.

The Grinnell Aut. Sprinkler Co., Providence, R. I.

Punching and Shearing Presses.
E. W. Bliss Co., Limited, Brooklyn, N. Y.
Long & Allstatter Co., Hamilton, Ohio.

Quarrying Machinery.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Ingersoll-Sergeant Rock Drill Co., 10 Park Pl., N. Y.
Trenton Iron Co., Trenton, N. J.

Sporting Goods.
Smith & Wesson, Springfield, Mass.

Steam Heating.
Boynton Furnace Co., 207-209 Water St., N. Y.
Gorton & Lidgerwood Co., 96 Liberty St., N. Y.
Hopson & Chapin Mfg. C., New London, Conn.
C. W. Mowry, Norwich, Conn.

Steam Hammers.
The Hackney Hammer Co., Cleveland, Ohio.

Steam Traps.
Stratton Separator Co., 32 Cortlandt St., N. Y.

Steel Importers.
Wm. Jessop & Sons, Limited, 91 John St., N. Y.

Steel Manufacturers.
Chester Steel Castings, Phila., Pa.
Wm. Jessop & Sons, Limited, 91 John St., N .Y.

Steel Rails.
New York Equipment Co., 15 Wall St., N. Y.

Steel, Tool.
Chester Steel Castings, Phila., Pa.
Wm. Jessop & Sons, Limited, 91 John St., N. Y.

Stocks and Dies.
Brown & Sharpe Mfg. Co., Providence, R. I.
The E. Horton & Son Co., Windsor Locks, Conn.

Stone Breakers.
Beckett Foundry and Machine Co., Arlington, N. J.
Copeland & Bacon, 85 Liberty St., N. Y.
Farrel Foundry and Machine Co., Ansonia, Conn.
S. R. Krom, 151 Cedar St., N. Y.

Street Railway Plants.
Edw. P. Allis Co., Milwaukee, Wis.
Edison General Electric Co., 68 Broad St., N. Y.

Street Railway Cars.
John Stephenson Co., Limited, New York.

Stone Working Machinery.
Ingersoll-Sergeant Rock Drill Co., 10 Park Pl., N. Y.

Steel Castings.
Audubon Machine Works, New Haven, Conn.
Chester Steel Castings Co., Phila., Pa.

Surveying Instruments.
F. W. Devoe & Co., 101 Fulton St., N. Y.
Young & Sons, Philadelphia, Pa.

Telegraph Wires and Cables.
Bishop Gutta Percha Co., 420-426 E. 25th St., N. Y.
New York Insulated Wire Co., 649-651 B'dway, N.Y.
John A. Roeblings Sons Co., Trenton, N. J.
The Okonite Co., 13 Park Row, N. Y.
Washburn & Moen Mfg. Co., Worcester, Mass.

Thermometers.
Hohmann & Maurer Co., Brooklyn, N. Y.
New England Fire and Heat Regulating Co., Boston, Mass.

Time Detectors, Electrical.
Cleveland Electrical Mfg. Co., Cleveland, Ohio.

Tools, Carpenters.
Stanley Rule and Level Co., New Britain, Conn.

Torpedo Boats.
The Atlantic Works, East Boston, Mass.

Tramways.
Brown Hoisting and Conveying Co., Cleveland, O.
C. W. Hunt, 45 Broadway, N. Y.

Tramways, Wire Rope.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
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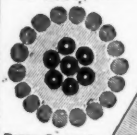

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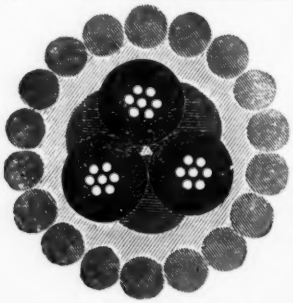

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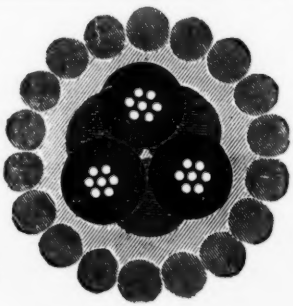

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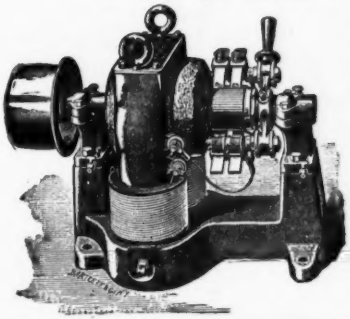

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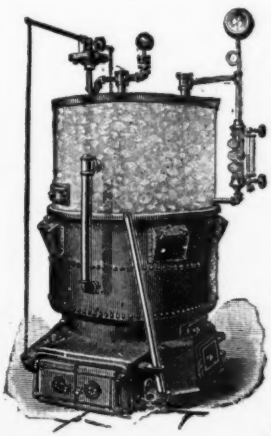

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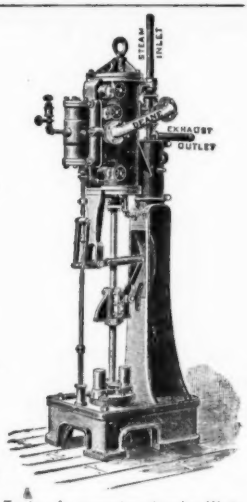

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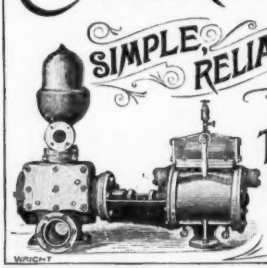

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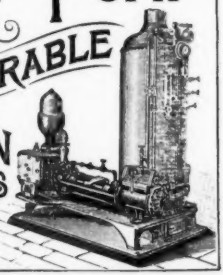

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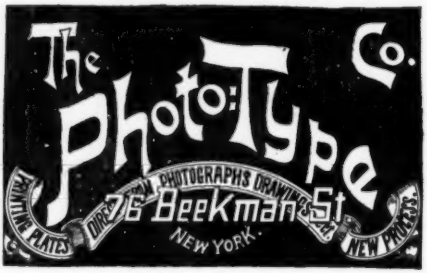

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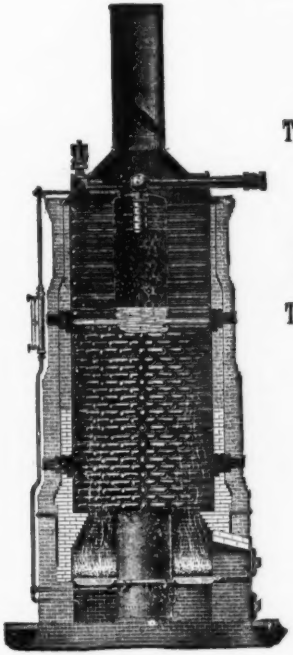

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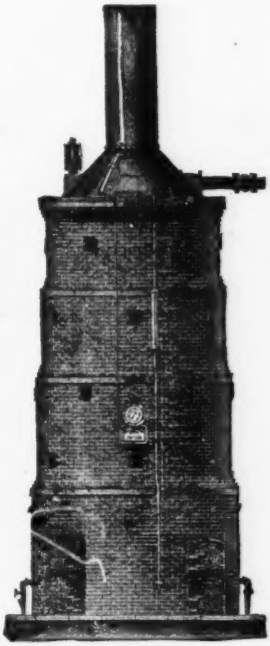

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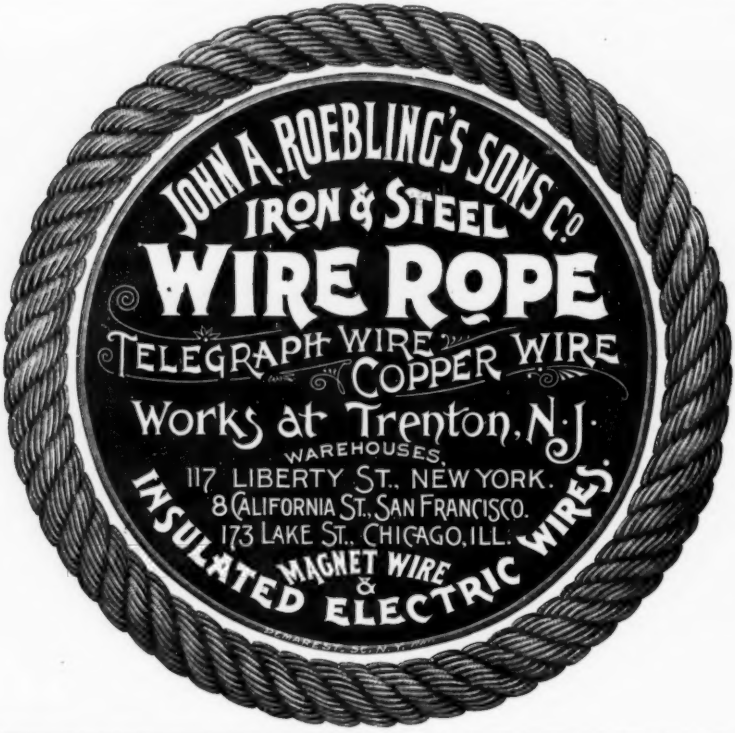

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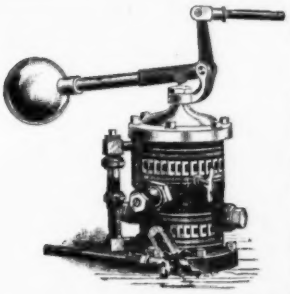

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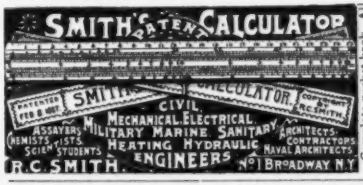

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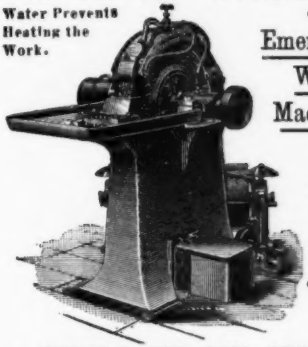

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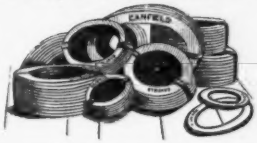

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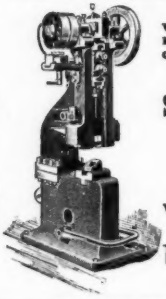

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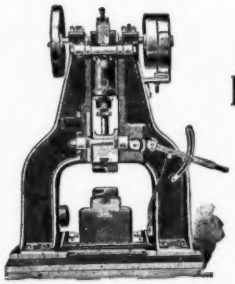

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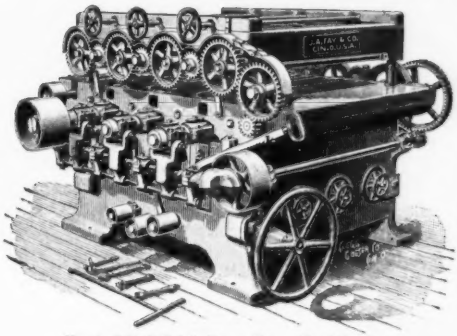

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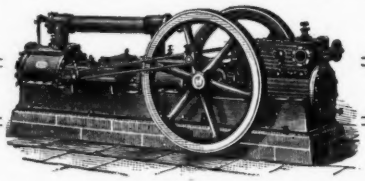

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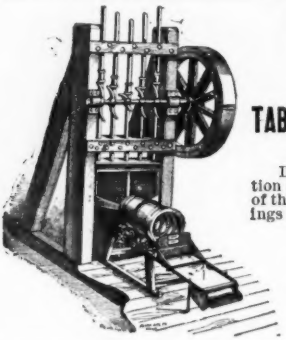

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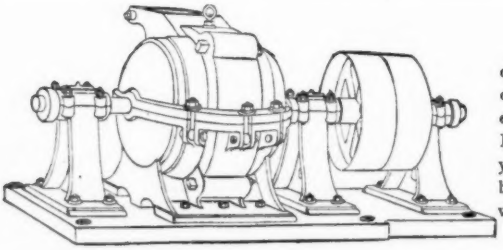

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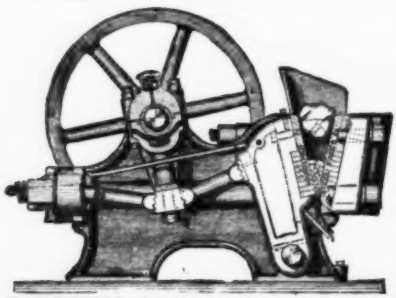

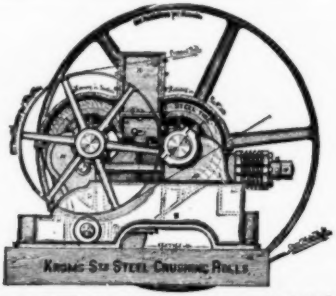

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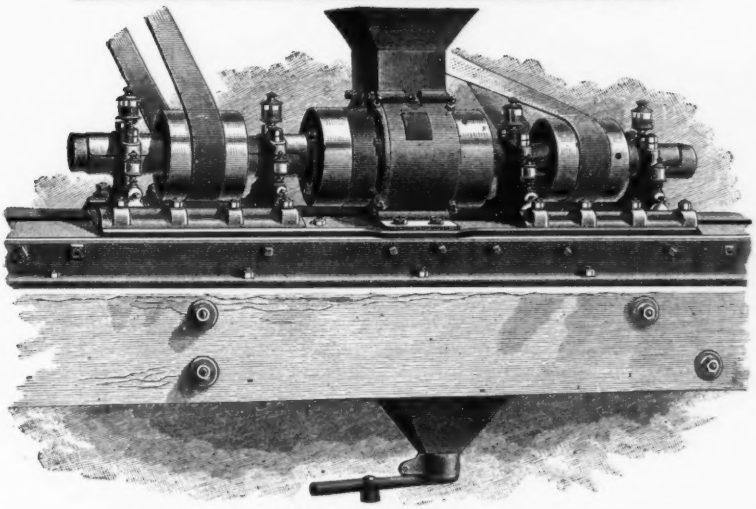

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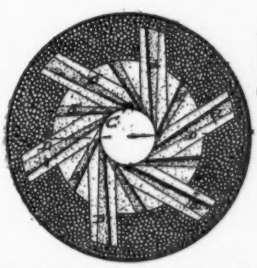

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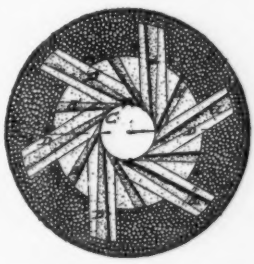

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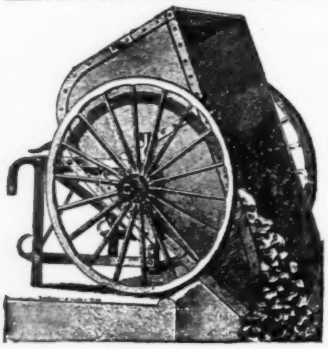

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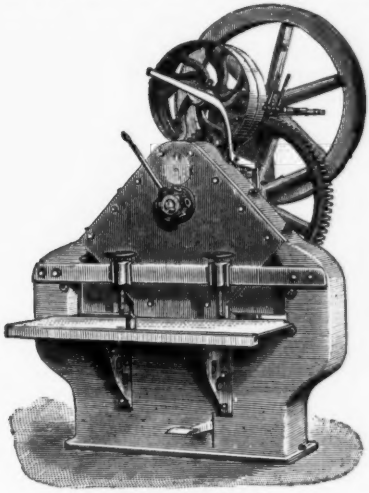

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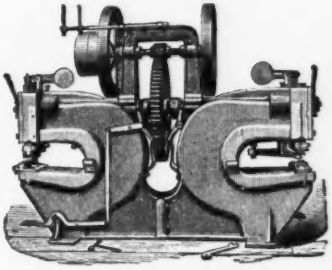

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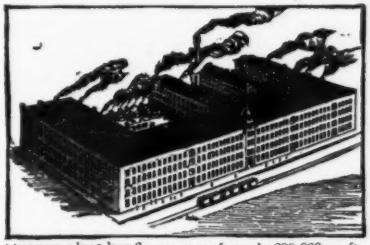

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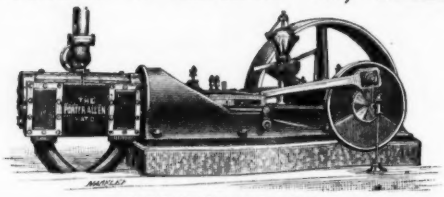

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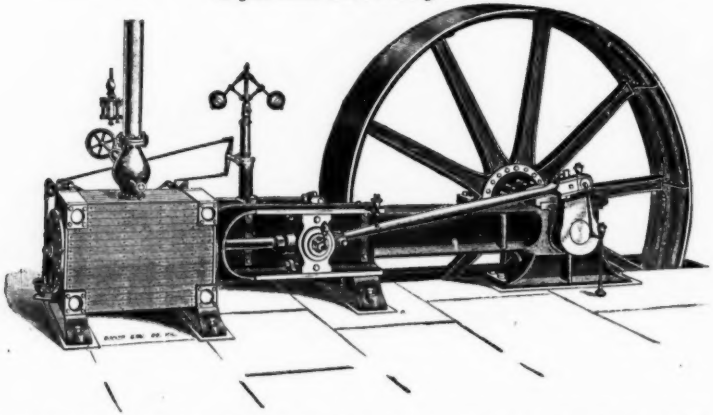

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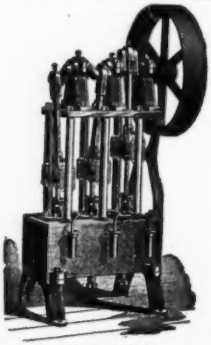

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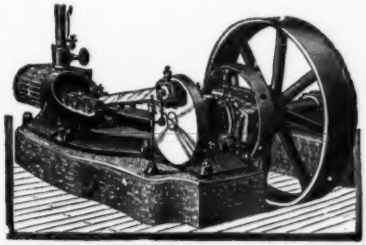

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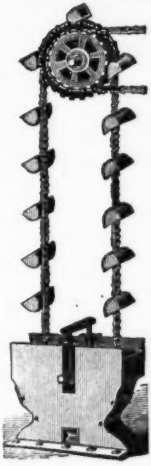

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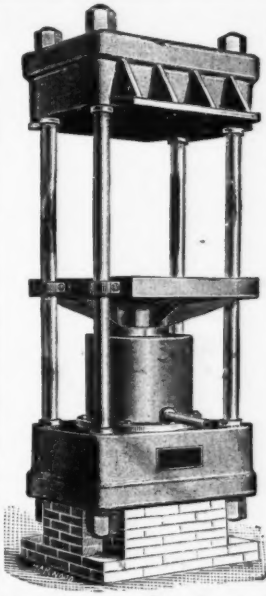

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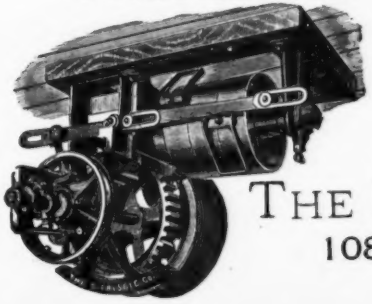

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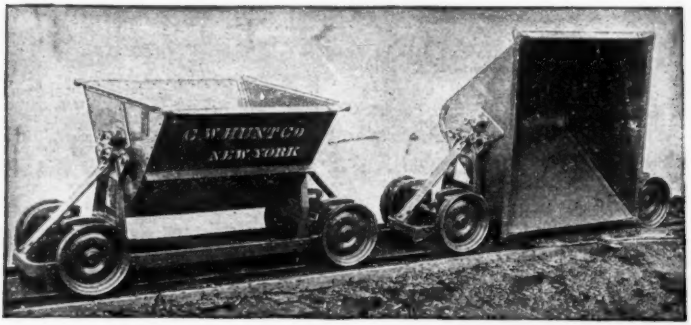

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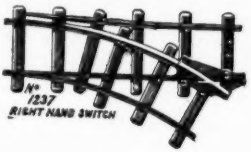

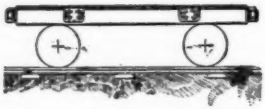

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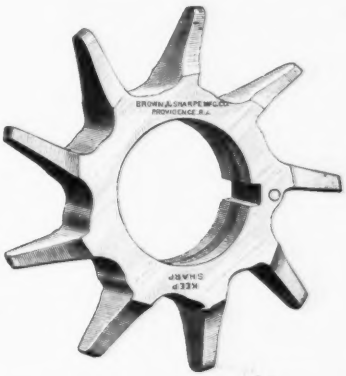

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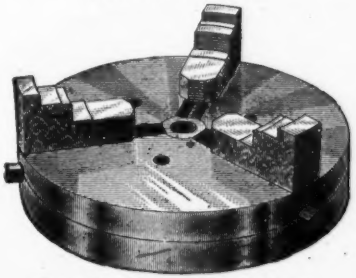

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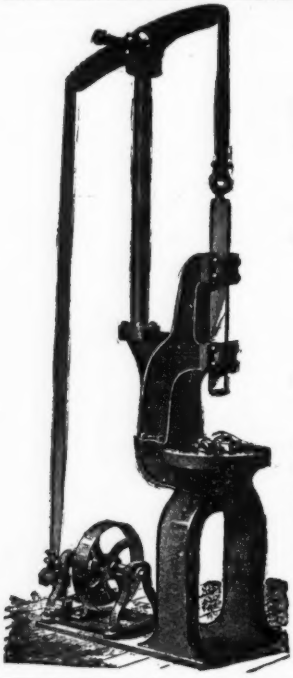

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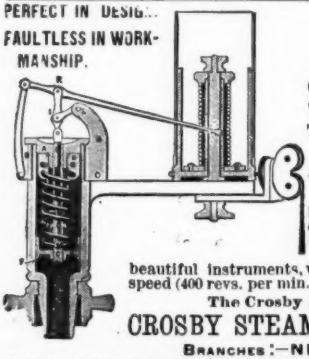

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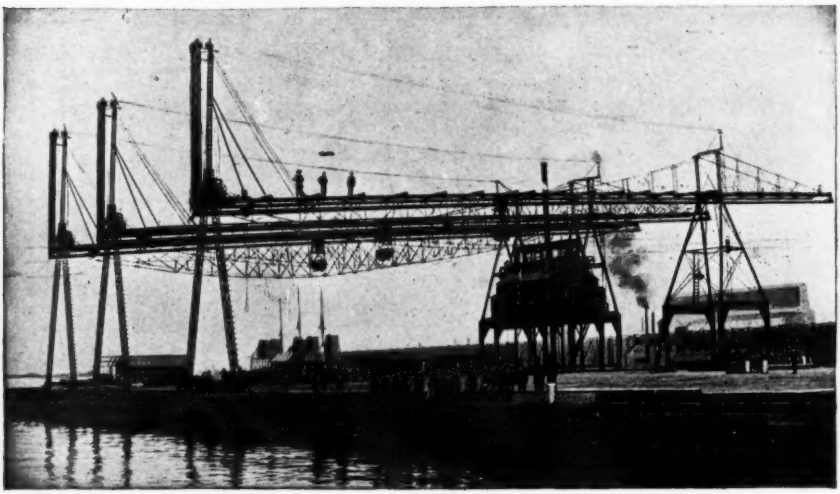

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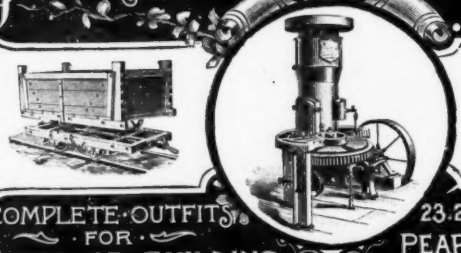

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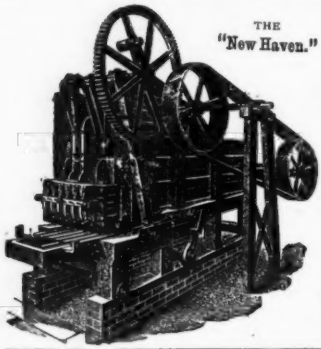

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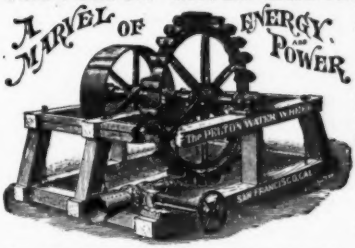

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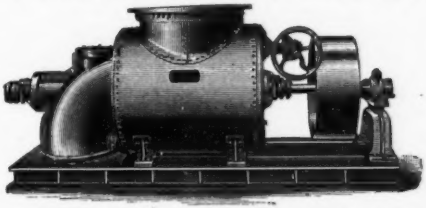

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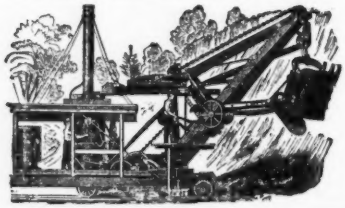

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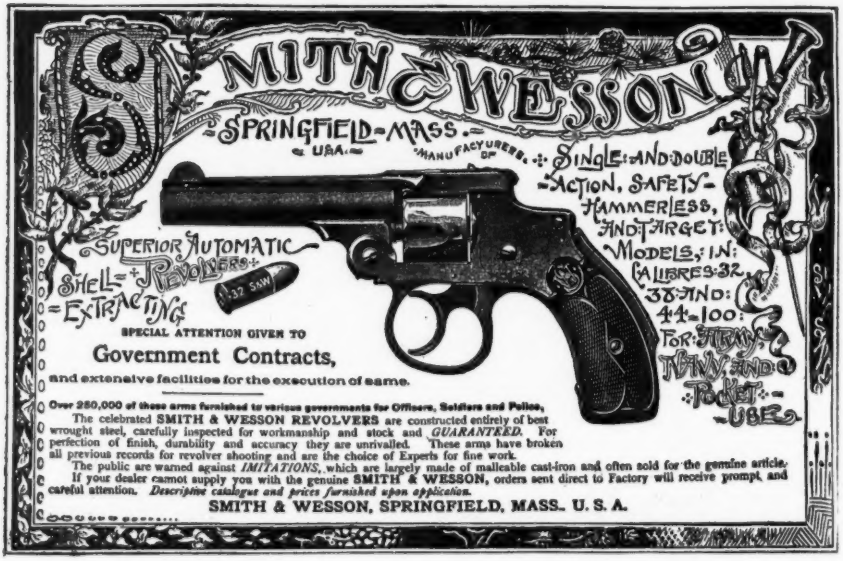
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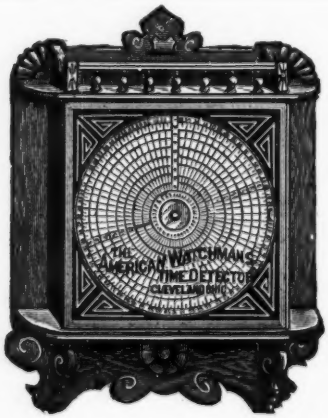

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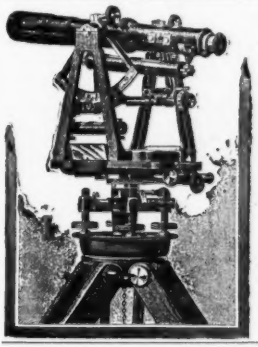

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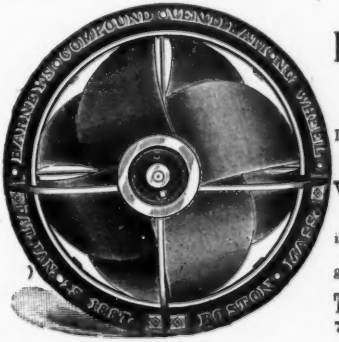

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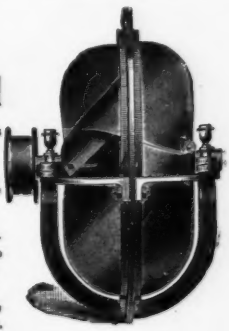

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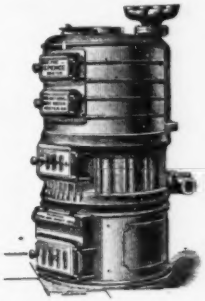

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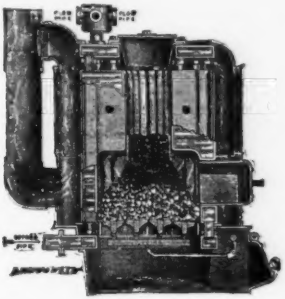

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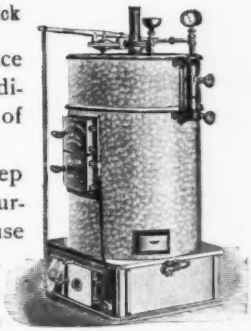

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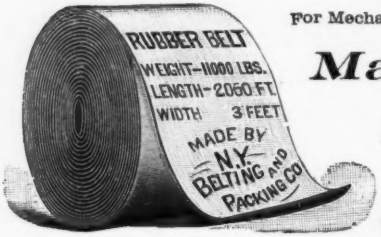

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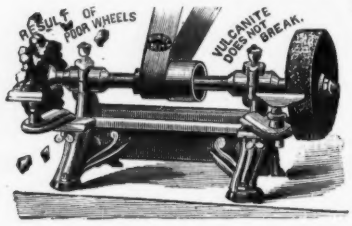

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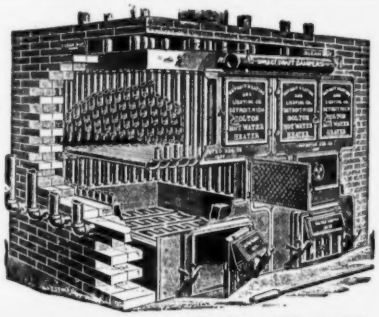

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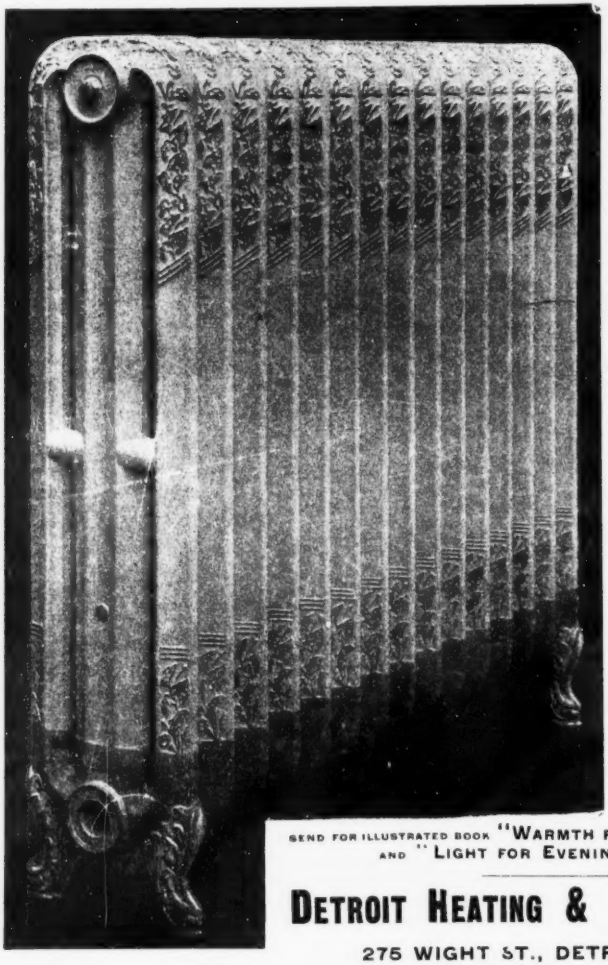

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